# TREES MEAN BUSINESS

A STUDY OF THE ECONOMIC IMPACTS OF TREES AND FORESTS IN THE COMMERCIAL DISTRICTS OF NEW YORK CITY AND NEW JERSEY

TREES NEW YORK & TREES NEW JERSEY

Trees Mean Business

# A STUDY OF THE ECONOMIC IMPACTS OF TREES AND FORESTS IN THE COMMERCIAL DISTRICTS OF NEW YORK CITY AND NEW JERSEY

Jan E. Bisco Werner
with
Jonathan Raser
Timothy J. Chandler
Margaret O'Gorman

Trees New York & Trees New Jersey

Funded by NUCFAC – the National Urban & Community Forestry Advisory Council

## PREFACE

## PART ONE: THE EXECUTIVE SUMMARY



## PART TWO: THE REGIONAL TRENDS ANALYSIS



## PART THREE: THE IMAGE-BASED VALUATION SURVEY

## PART FOUR: THE LOCAL CASE STUDIES



## APPENDICES



## BIBLIOGRAPHY

# Preface

## about the partners

### Trees New York

Trees New York (TNY) is a nationally acclaimed environmental/forestry organization working with all New York City communities. TNY has promoted its partnership with NYC's communities since it's founding in 1976 as the NYC Street Tree Consortium. Its mission is to plant, preserve, protect, educate and care for New York's trees as a people-oriented organization dedicated to community self-help. Its goal is to provide a better quality of life for NYC's communities through the living component of their infrastructure with trees and tree-related endeavors. Through such crucial, direct, community-oriented endeavors as technical support services education/training programs for children, youth and adults, desktop publishing projects and advocacy efforts, TNY has had a tremendous impact on the restoration of New York's streetscapes, open spaces and environment.

### Trees New Jersey

Trees New Jersey (TNJ) is a statewide nonprofit organization that cultivates greener communities through education and citizen action. It was organized as New Jersey ReLeaf in 1990 to provide assistance to volunteers, municipal decision-makers and professionals who were looking to improve the quality of life in their community by protecting, preserving and making plans to enhance their municipality's green infrastructure – its street trees, parks and open space. TNJ's school-based and community-based education programs, support services and publications build partnerships, empower people of all ages to take action, instill a sense of community and grow healthier community forests. Whether in rural, suburban or urban communities, TNJ has effectively empowered people of all ages to take responsibility for enhancing their local environment.

## Project Staff

**Project Executive Director**
Barbara J. Eber-Schmid
*Trees New York*

**Project Director**
Jan E. Bisco Werner
*Trees New Jersey*

**GIS Project Manager**
Jonathan Raser, *Cedar Lake Environmental*

**IBVS Project Manager**
Jan E. Bisco Werner, *Trees New Jersey*

**IBVS Pre-Test Project Manager**
Timothy J. Chandler, *consultant*
*Princeton University Graduate Program*

**New Jersey Case Study Team Leaders**
Margaret O'Gorman, *TNJ*
Jan E. Bisco Werner, *TNJ*

**New York City BID Case Study Team Leaders**
Susan Gooberman, *TNY*
Barbara J. Eber-Schmid, *TNY*

**NY & NJ Case Study Field Data Collection Team**
Jan E. Bisco Werner, *TNJ*
Jonathan Raser, *CLE*
Jason Nuckols, *TNY*

**IBVS Team**
Jan E. Bisco Werner, *TNJ*
Timothy J. Chandler, *consultant*
Margaret O'Gorman, *TNJ*

**Project Research and Development Staff**
Heleigh A. Bostwick, *TNJ*
Susan Gooberman, *TNY*
Harriet Honigfield, *consultant*
Kerrie Lough, *TNY*
Jason Nuckols, *TNY*
Margaret O'Gorman, *TNJ*
Jennifer Persons Chidichimo, *TNJ*

**TNY & TNJ Project Interns**
Sarah Cohen, *Smith College*
Nicole Highland, *Rutgers University, Cook College*
Anita Pahuja, *Brown University*
Tanisha Madrid, *Columbia University*

**Graphic Design**
Jonathan Wilson, *JW Studios*

**Project Advisory Committee**
Herb Abelson, *Princeton University, Woodrow Wilson School*
Frank Addeo, *NYC Dept. of Transportation*
Jeffrey Albert, *Avalon Properties*
Clint Andrews, *Rutgers University, Bloustein School*
Sandra Bertelson, *Avalon Properties*
Ann Brady, *MSM Regional Council*
John P. Carman, *Design for Generations*
T. J. Chandler, *Planning Consultant*
Roy DeBoer, Jr., *Matzel & Mumford*
Jim Gilday, *Hodnet/Gilday*
Andrew Haughwout, *Princeton University, Woodrow Wilson School*
Bob Heilig, *CUH2A, Inc.*
Mark Knowlton, *Rutgers University, Cook College*
Dan Knox, *Mercer County Planning Division*
Don Krueckeberg, *Rutgers University, Bloustein School*
Tamara Lee, *ASLA*
William R. Lough, *William B. Lough Associates*
Anton Nelessen, *Nelessen Associates*
Carl Nordstrom, *NJDEP, Division of Parks & Forestry*
Margaret O'Gorman, *Pinelands Preservation Alliance*
Jonathan Raser, *Cedar Lake Environmental*
John Reymann, *Hamilton Township*
David Roberts, *Schoor DePalma*
Carlos Rodriguez, *Office of State Planning*
Donald Scarry, *New Jersey Economics*
Steve Strom, *Rutgers University, Cook College, Landscape Architecture Department*
Henry M. White III, *H.M. White Site Architects*

## Acknowledgements

This research project was made possible by the generous support of the National Urban and Community Forestry Advisory Council (NUCFAC). NUCFAC, like Trees New York and Trees New Jersey, understands the value of urban and community forests – the forests where we live. This project came about because of the mutual desires of these three groups to better understand the link between the green infrastructure and the economics within commercial districts, as well as the connection to the general well being and stability of the surrounding neighborhoods and communities.

We would especially like to extend our thanks to the professionals on the project advisory committee who helped us bring the study into focus to achieve tangible results. Additionally we thank other professionals who volunteered their services to give research direction for the project – Herb Abelson of Princeton University Woodrow Wilson School and Steve Strom of Rutgers University Cook College Landscape Architecture Department. We are greatly appreciative to David Nowak of USDA Forest Service Northeastern Area Research Station for reviewing our data and methodology for the local and regional study, as well as providing us with the UFORE analysis of selected case studies.

A special thanks to Jon Raser of Cedar Lakes Environmental for painstakingly collecting data and running the GIS analysis for both the regional and local studies. We also thank our GIS partners who provided us with assistance, information, data and maps – New Jersey Non-Government Organization GIS Users Group, Upper Raritan Watershed Association, Middlesex County Planning Department, Mercer County Planning Department, Mercer County Soil Conservation District, Delaware Valley Regional Planning Commission (DVRPC), Regional Planning Partnership (MSM Regional Council), Environmental Science Research Institute (ESRI), New Jersey Department of Environmental Protection (NJ DEP) and the NJDEP/ESRI Non-Governmental Organization Software Donation Program, as well as the municipal planners and landscape architects and other professionals who provided their time and various site plans for our use. We would especially like to thank Dan Dobromilsky, CLA, Doug Schleifer, Mary Jane Felgenhauer, Bill Kruse and Bill Brash for their assistance throughout the project.

We appreciate the assistance from American Forests with providing frequent software updates and helping us through the glitches that we experienced – with a special thanks to Ken Gorton and Alice Ewen-Walker for their understanding of the software and their patience in answering all of our questions.

We thank the Firehouse Art Gallery in Bordentown, Mercer County Community College, NJ DEP & NYC DOT for allowing us to hold our image-based preference surveys on their premises. We offer a special thank you to Anthony Nelessen and Associates for sharing slides from their tremendous slide file and for providing us with information on their Visual Preference Survey™ techniques.

We thank the developers, owners and/or managers of the case study sites and the New York City Business Improvement District (BID) managers who gave their time for interviews and providing detailed information about the sites.

We thank Mercer County Freeholder Robert Prunetti and his staff for providing us with access to the Mercer County Arena plans in Trenton. A special thanks to Randy Baum, CLA, for giving his time and for sharing the City of Trenton maps and ordinances. We also thank the helpful staff and the directors of the Mercer County Planning Department and the Middlesex County Planning Department who seem to know and remember everything that is happening and has happened in their counties over decades.

New York City Parks Department's Fiona Watt, Jennifer Greenfield, Jackie Lu and Bram Gunter were extremely helpful and we thank them for their cooperation and help.

And to all those who had a hand in this research, but were not mentioned because of limited space, we offer our sincere thanks for your time and the information you shared with us.

Jan E. Bisco Werner
**Project Director**

Barbara J. Eber-Schmid
**Project Executive Director**

# EXECUTIVE SUMMARY

## Introduction

There is little doubt that trees add value to our lives. At a global scale, forests are major players in the carbon and oxygen cycles. Forests also help moderate temperatures and provide habitat for millions of animal species. Trees, the defining element of forests, play important roles in the lore and mythology of many cultures as symbols of life, knowledge, protection, longevity and fertility.

The role of trees in communities is equally relevant, yet more subtle – particularly in urbanized areas like those found in New Jersey, the most densely populated state in the nation and in New York City, the most densely populated city in the United States of America. In cities and suburbia, trees are generally thought to reduce the urban heat island effect, improve the air quality, increase the attractiveness of areas, reduce stormwater runoff and provide recreational opportunities. Some have even postulated that the presence of trees improves work performance, speeds recovery after surgeries and promotes community spirit.

As commercial development and redevelopment continue to engulf much of the remaining forested lands in the New Jersey/New York City region and elsewhere across the country, citizens and elected officials are concerned that not enough actions are being taken to sufficiently plan for the preservation of these urban forests. Why? Is it because only a few people see the value of the trees and forests on these lands, when compared with other land uses that are viewed for their potential wealth and revenue generation?

Indeed, the benefits that trees provide are almost pure public goods. That is, trees and forests provide benefits that may be enjoyed by anyone (i.e. they are non-exclusionary) and the cost to produce those benefits is the same regardless of how many people receive them (i.e. they are non-rival). Because of these qualities, it is likely that the economic market in both the public and private sector will discount or ignore the value of trees and under-provide them in commercial development and redevelopment projects. After all, once a tree is planted, it is nearly impossible to charge people for the enjoyment of its environmental, aesthetic, or symbolic values. As such, commercial developers in general will provide as few trees as required in order to minimize costs for which there are no perceived compensatory revenues.

On the other hand, some of the benefits of trees may indirectly be considered as private goods. For example, landscaping on residential properties may increase home values; neighborhood parks in residential areas may increase the value of nearby residential properties; improved air quality may lower health care costs; the reduction of stormwater runoff from the presence of trees and other vegetation may decrease the need for costly retention basins; and the preservation of tracts of forested land on sites being developed may reduce the construction costs generated by tree removal and site grading. Although there will always be pure public benefits from trees and forests, the identifiable and quantifiable private benefits are the benefits that will provide incentives for developers to include trees and other vegetation in their site plans.

Likewise, municipal tree and/or landscape ordinances and public planning requirements are based on identifiable and quantifiable public benefits. Identifying and quantifying these benefits would effect real change in commercial development and redevelopment practices, as well as the public policies that preserve existing forested lands. Commercial developers and property owners, along with decision-makers in local and regional governments may be willing to invest more in the planning and care of the green infrastructure on commercial properties if tangible economic benefits can be clearly shown.

It is not our intent to take an anti-development position. Rather it is our intent to promote a more harmonious approach to development by taking the stance that a green infrastructure complements economic viability. In other words, this study supports the supposition that promoting greener commercial development, as well as encouraging the greening and protection of trees in established commercial districts makes good business sense.

## Project Summary

The U.S. Forest Service (USFS) through the National Urban and Community Forestry Advisory Council (NUCFAC) provided grants to several organizations to try to quantify the values of trees and urban forests in economic terms. One grant was awarded to an interstate partnership between two nonprofit organizations – Trees New York (New York City Street Tree Consortium, Inc.) and Trees New Jersey (New Jersey ReLeaf, Inc.). The purpose of this study was to analyze and document the economic impact of urban and community forests in commercial districts in New York City and New Jersey.

Trees New York (TNY) and Trees New Jersey (TNJ) conducted this research to generate quantifiable data and subjective valuation as related to trees and urban forests in commercial areas within the region. It was hypothesized that over the years there had been a steady loss of forest cover in commercially zoned suburban areas, as well as in downtown urban areas. The study examined the trends of forest loss in commercial districts within the region and sought to quantify the public and private benefits of these forests. This was accomplished through the use of Geographic Information Systems (GIS) software, existing scientific modeling techniques and interviews.

Additionally the values that users/customers placed on green commercial sites were measured through an image-based valuation survey of retail shopping areas. This was designed to estimate the importance that customers placed on the landscape at shopping centers and to estimate their willingness to pay more to shop at greener locations.

Finally, commercial sites in both states were selected as case studies. The private and public benefits of the trees on the selected sites were quantified, while the perceived values of trees on commercial properties were extracted from the commercial property owners and/or developers. Developers, owners or business improvement district managers/staff of selected sites answered questions through anecdotal interviews and/or surveys to determine what values they placed on their respective commercial property's landscape. The last step in the case study analysis measured the benefits of trees on the selected sites using GIS software and hypothetical growing simulations.

Based upon the data collected and analyzed, TNY and TNJ made recommendations for reversing the trend of tree loss from commercial development and re-development projects, as well as for promoting the benefits of the urban forest resource to the developers, users and decision-makers.

### Study Hypotheses

The general hypothesis of this project was that the green infrastructure of commercial sites complemented a site's economic viability, while it provided regional benefits that improved the quality of life for people living in the area. It was also believed that customers preferred greener retail establishments, whether hotels, malls, shopping centers or downtown districts. And although the hypothesis was yet to be proved, researchers speculated that few developers or owners voluntarily planted trees to replace the trees and valuable forested lands lost during new commercial developments. Another related correlation was that in the older, established commercial areas, few trees were replanted when they died or were removed unless required by local regulations. It was also hypothesized that the greener commercial developments had owners and/or management that linked their level of onsite landscaping with their ability to compete with similar retail establishments for customers and/or tenants. And finally it was hypothesized that if the less green sites improved their green infrastructure by adding more trees or enhancing their landscape, they increased their ability to compete for customers and/or tenants and increased their potential for success.

### Study Objectives

The primary goal of this study was to prove the value of trees and urban forests on commercial properties, so as to encourage more environmentally sound commercial development and redevelopment practices. The objectives of the study were:

- to analyze the regional trends concerning the loss of urban forests during commercial development and redevelopment;
- to quantify the benefits of urban forests within commercial districts on a regional scale and to quantify the decrease in benefits due to urban forest loss;
- to identify the main influences that determine the landscape investment of commercial properties;
- to determine the perceived value of green commercial sites by the developers and/or property owners;
- to determine consumers' shopping and parking preferences;
- to estimate the economic value that consumers place on trees and landscaping at retail shopping areas by quantifying their willingness to pay to shop at greener sites; and
- to quantify the benefits of trees and forests on selected commercial sites.

### Study Methodology

## Developing Project Partnerships

A project team was developed that included TNJ staff, TNY staff and outside consultants. The team met often over a three-year period in New York City and New Jersey. A project advisory committee (PAC) was also developed to help focus the study and provide professional advice as needed throughout the project. The PAC was extremely helpful in evaluating the quantifiable and subjective techniques/methods that were proposed by the project team. They also provided advice on the final project recommendations upon completion of the study. In addition to the PAC, other professional partnerships were developed to provide project support or a venue for sharing project information. These partnerships were listed in the Preface.

## Selecting the New Jersey Study Area

The US Route 1 corridor from Trenton to New Brunswick in New Jersey was chosen for study as it contained a fair cross-section of both mature urban and rapidly growing suburban areas, with an associated range of commercial environments. It traveled through seven municipalities with varying regulations and varying rates of development. The land adjacent to the corridor consisted of farmland, forested areas, old and new commercial development and residential development. The types of commercial development varied, as did the type and quality of the green infrastructure on the sites. The type of commercial development occurring along the corridor was typical of what was happening in suburban areas across the country. The following demographics provided a picture of the region that surrounded the study area – the population that used the commercial areas within the study area. These demographics were also useful to readers of the study who wanted to compare it with the demographics in their region.

The median household income of the population living in the municipalities within the New Jersey study area was $62,911 with 15% of the area population having household incomes more than $100,000 and 51% having less than a $50,000 household income. (figure 1.01) West Windsor had the highest median household income ($93,755) and Trenton and New Brunswick had the two lowest median household incomes, $34,259 and $37,791 respectively. (figure 1.02)

The racial demographics of the population of the municipalities in the study area as of 1999 estimate 58% Caucasian, 27% African-American, 8% Asian/Pacific Islander and 6% other races, including Native Americans. Of the 253,986 people in the area 11.5% were Hispanic, which was not considered a race in the census data. (figure 1.03)

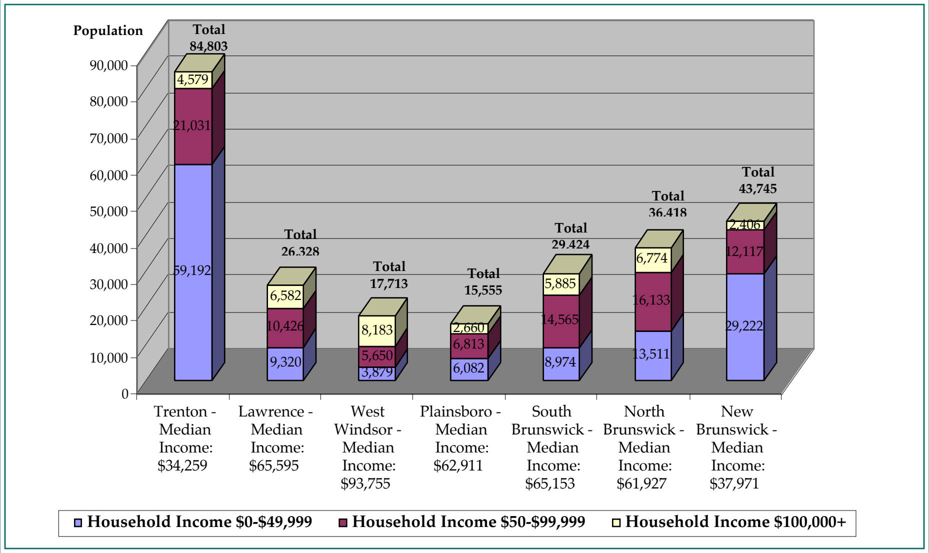



*figure 1.02. Household income demographics of New Jersey municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

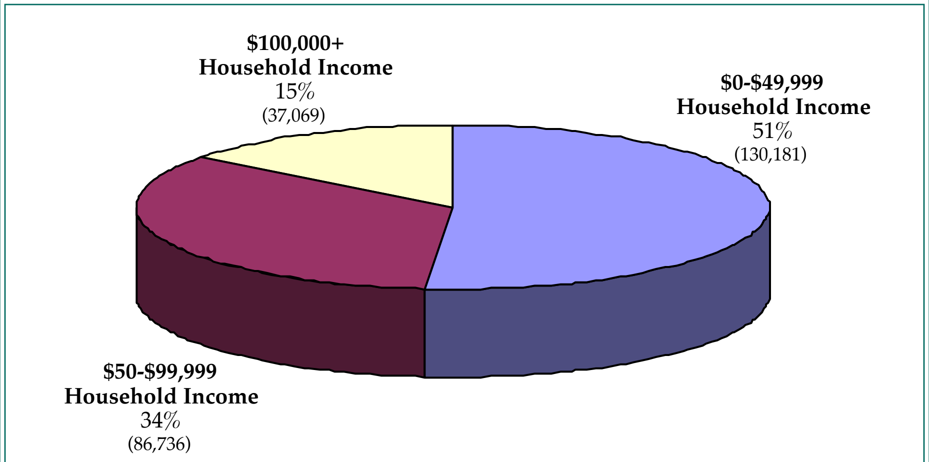



*figure 1.01. Household income demographics for New Jersey region that includes municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

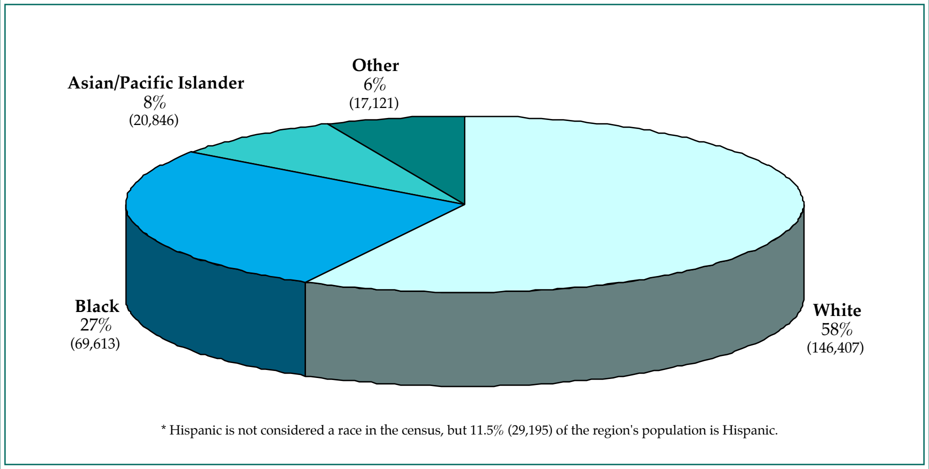



*figure 1.03. Racial demographics for New Jersey region that includes municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

Lawrence Township had the highest percentage of Caucasians (80%) with the neighboring City of Trenton having the lowest percentage (34%). West Windsor Township had the lowest percentage of African-Americans (4%) and Trenton the highest percentage (52%). There were less Asian and Pacific Islanders than any other race in the region with Trenton having the lowest percentage (1%) and West Windsor the highest (23%). 13% of New Brunswick and 10% of Trenton were listed as other races, including Native Americans, whereas all the other municipalities had between 1% and 4% listed as other races. Trenton had the largest Hispanic population (18%) closely followed by New Brunswick (13%) and North Brunswick (10%). The remaining communities had a Hispanic population between 4% and 6%. (figure 1.04)

17% of the population in the area was older than 54 years and 38% was younger than 24 years. (figure 1.05) The city of New Brunswick had the highest percentage of population under the age of 24 years (51%). It was the home of Rutgers University; thus a large percent of students under the age of 24 lived in the area. The rest of the municipalities in the study area indicated that between 32% and 38% of their populations were in that same age bracket. Plainsboro Township had the largest percentage of their population between the ages of 24 and 54. The townships of West Windsor, South Brunswick and North Brunswick closely followed with 50% to 52% of their populations between the ages of 25 and 54 years of age. Two of the older municipalities, the City of Trenton and Lawrence Township, had the oldest population with 21% and 22% of their population over the age of 55 years. Plainsboro Township, one of the communities sporting recent residential growth, had the lowest percent of their population over 55 years of age, only 7%. (figure 1.06)

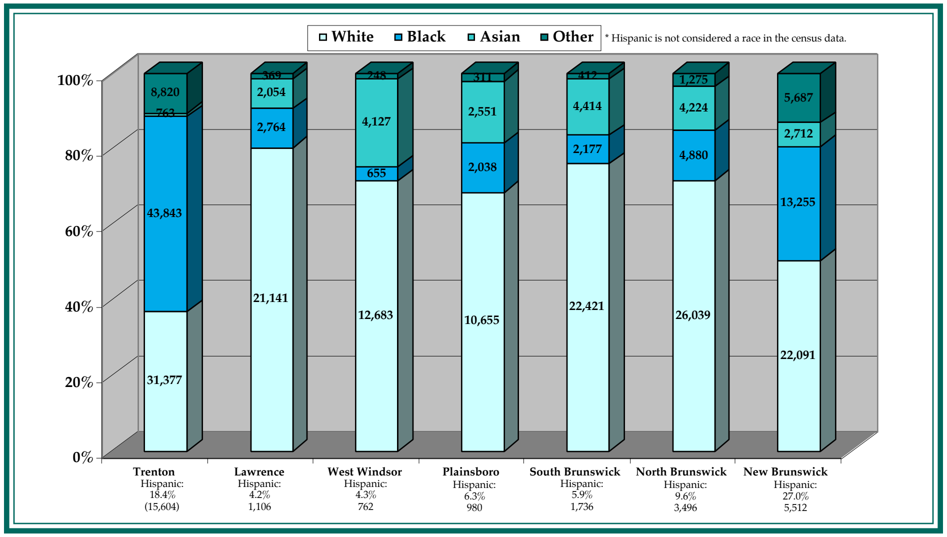



*figure 1.04. Racial demographics of New Jersey municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

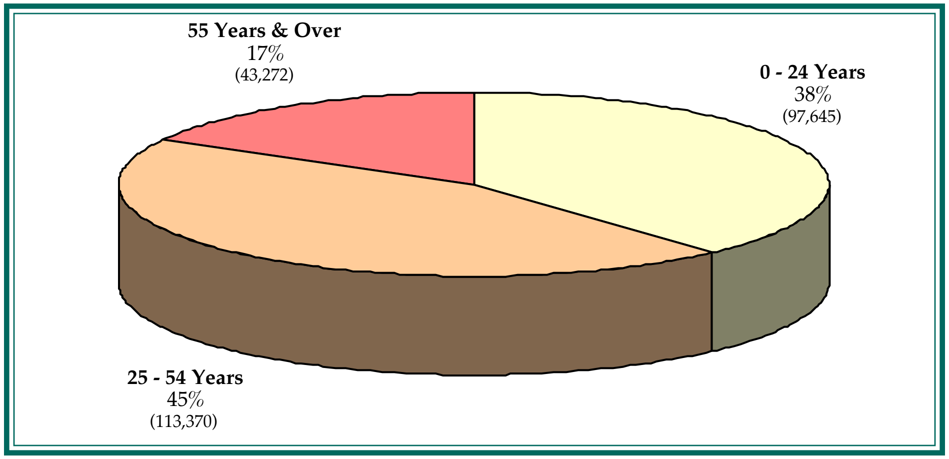



*figure 1.05. Age demographics for New Jersey region that includes municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

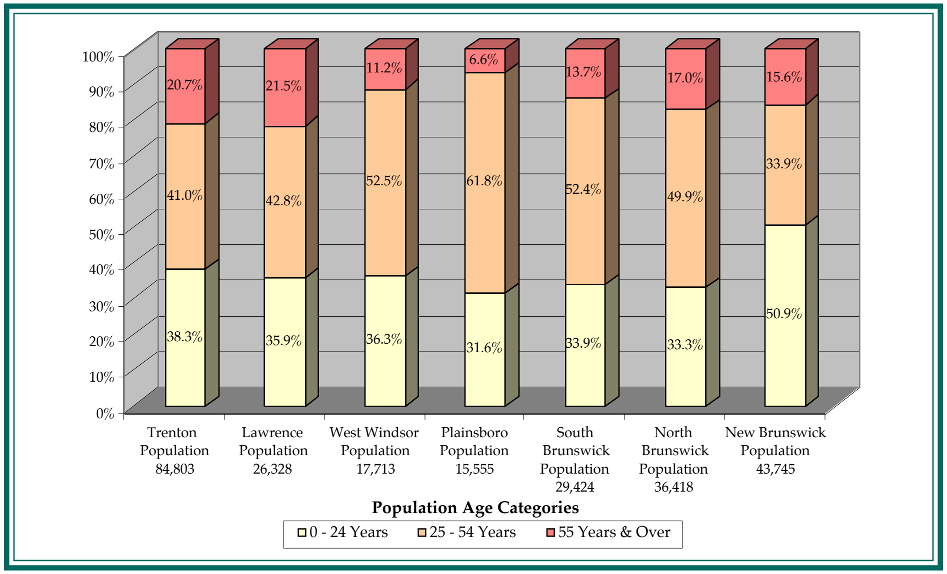



*figure 1.06. Age demographics of New Jersey municipalities in the US Route 1 corridor study area. (Source: CACI, 1999 Estimates and Projections)*

The New Jersey study area along the US Route 1 corridor (not including Trenton) encompassed 12,037 acres with 45% commercially developed, 24% residentially developed and 31% undeveloped. (figure 1.07)Within the 5,375 acres of commercial land, approximately 20% of the acreage was offices and 21% was manufacturing or industrial sites. Mixed commercial was found in 33% of the area, which included hotels/motels, utilities, transportation corridors, research, institutions and mixed use/ neighborhood commercial. The remaining 26% contained retail commercial sites. For the regional analysis all of the area was considered, but only retail commercial sites and hotels were selected for the local case studies. (figure 1.08)

The US Route 1 corridor area selected for the study area was a diverse region that was representative of many communities across the country. It included high and low economic areas, populations with age and racial diversity, commercial development, as well as old cities and developing suburbs.

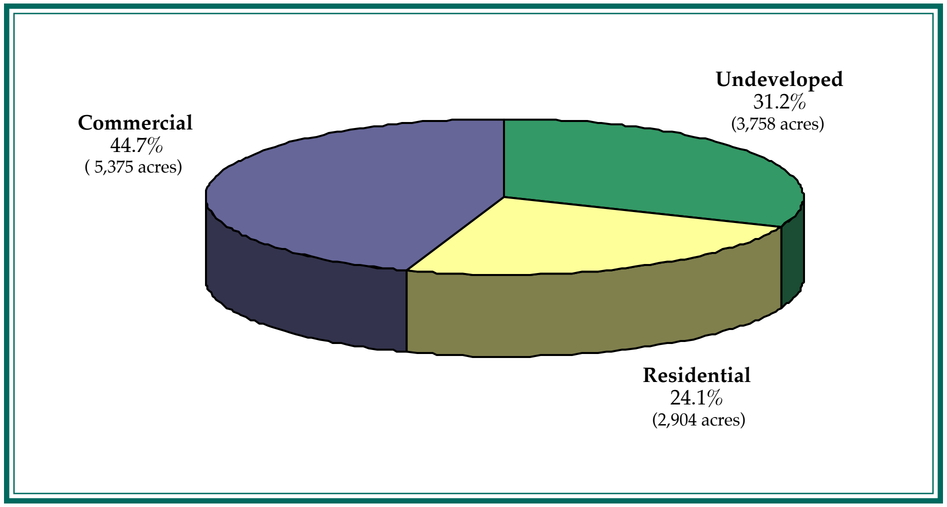



*figure 1.07. Regional land uses types in New Jersey along US Route 1 corridor study area. (Does not include the City of Trenton)*

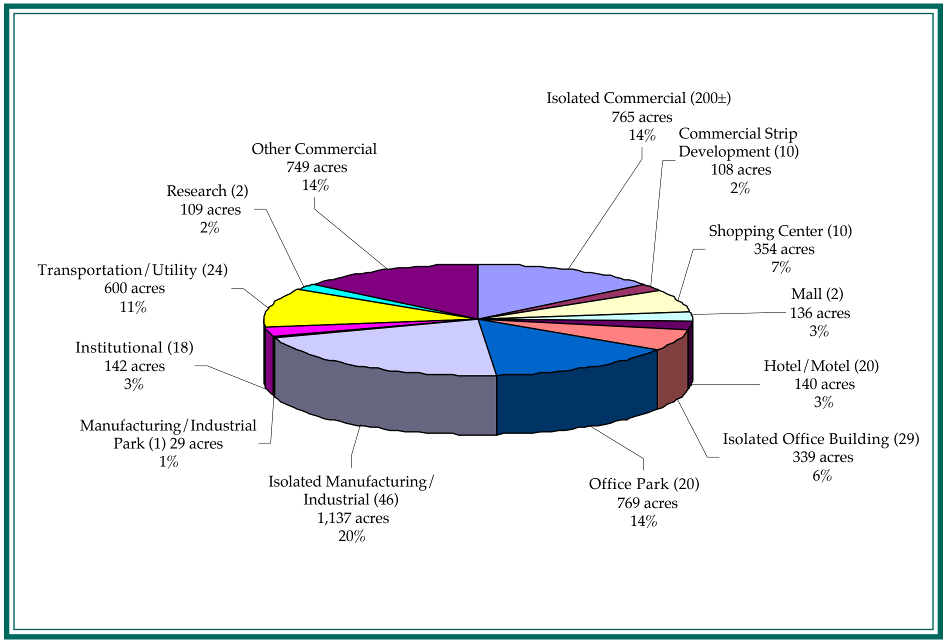



*figure 1.08. Types of commercial land use in New Jersey along US Route 1 corridor study area. (Does not include the City of Trenton)*

## Selecting the New York City Study Area

None of the areas within the New Jersey study area contained skyscrapers as were found in New York City and other large cities in the country. Because of this New York City was selected to complete the study area. New York City consists of five boroughs – Manhattan, Queens, Brooklyn, the Bronx and Staten Island. Business Improvement Districts (BIDs) were identified as suitable sites to study within New York City (NYC). BIDs were nonprofit corporations created by the City of New York to develop and administer revitalization and self-improvement programs within a defined geographical area. In essence, they levy a "tax" on area businesses to pay for the services they provide. They were defined districts with groups of commercial entities, which allowed researchers to study them as a group of businesses, rather than in isolation. BIDs had active redevelopment activities that could be evaluated. BIDs also provided a specific point person for its district, rather than one person for each building or commercial establishment. BIDs were not unusual phenomenon specific to New York City. They were being established in various formats in cities across the country to revitalize their commercial districts.

BIDs were in all boroughs of NYC with the exception of Staten Island. All BIDs within NYC were sent an initial survey. After analyzing the information from the surveys, TNY selected BIDs for the study based on such factors as information accessibility, the diversity of the population that used the areas for business, shopping, interest in participating in the study and their location. All BIDs selected were located in Manhattan. Manhattan, an island of 28.63 square miles (18,326 acres), had neighborhoods of residential, commercial and mixed use. The four BIDs selected to study encompass 0.26 square miles (166.62 acres).

The following demographics describe the population of Manhattan, the main users of the selected NYC BIDs. The median household income for Manhattan was $46,827. 57% of the city had annual incomes of less than $50,000 and 20% of them had annual incomes of more than $100,000. (figure 1.09)

The regional population demographics in Manhattan indicate that 52% of the population was Caucasian, 23% was African-American, 10% was Asian/Pacific Islander and 15% was considered other races, including Native Americans. Of the 1,559,687 people in Manhattan, 31% were Hispanic, which was not considered a race in the census data. (figure 1.10)

22% of the population in Manhattan was older than 54 years and 27% was younger than 25 years, with the remaining half of the population between the ages of 25 and 54 years. (figure 1.11)

Manhattan, like other old densely populated cities, includes high and low economic areas and populations with age and racial diversity, therefore being representative of many large cities across the country.

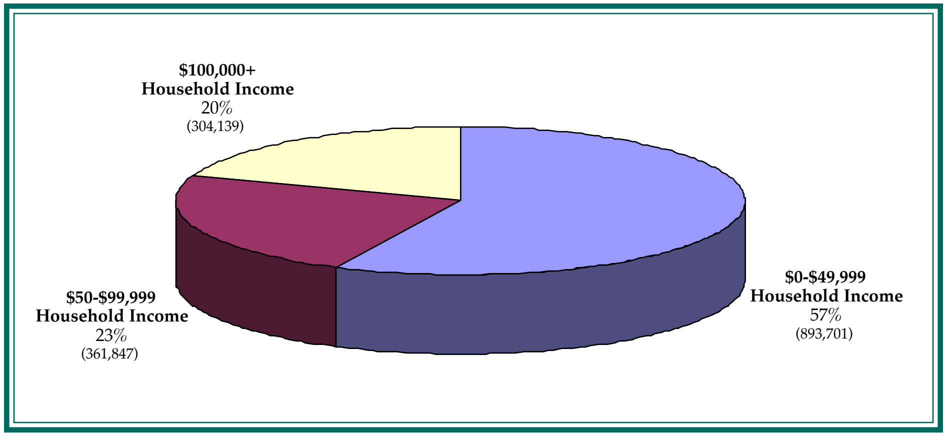



*figure 1.09. Household income demographics for Manhattan (New York City). (Source: CACI, 1999 Estimates and Projections)*

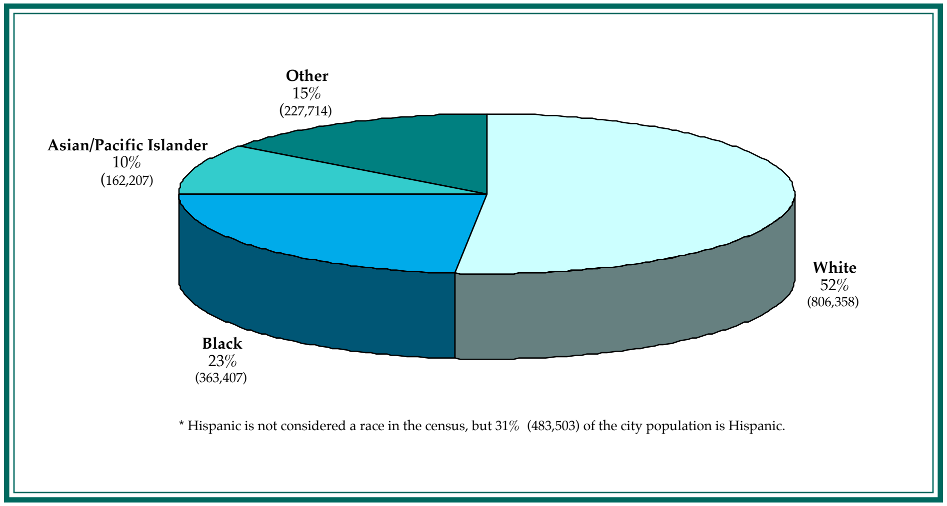



*figure 1.10. Racial demographics for Manhattan (New York City). (Source: CACI, 1999 Estimates and Projections)*

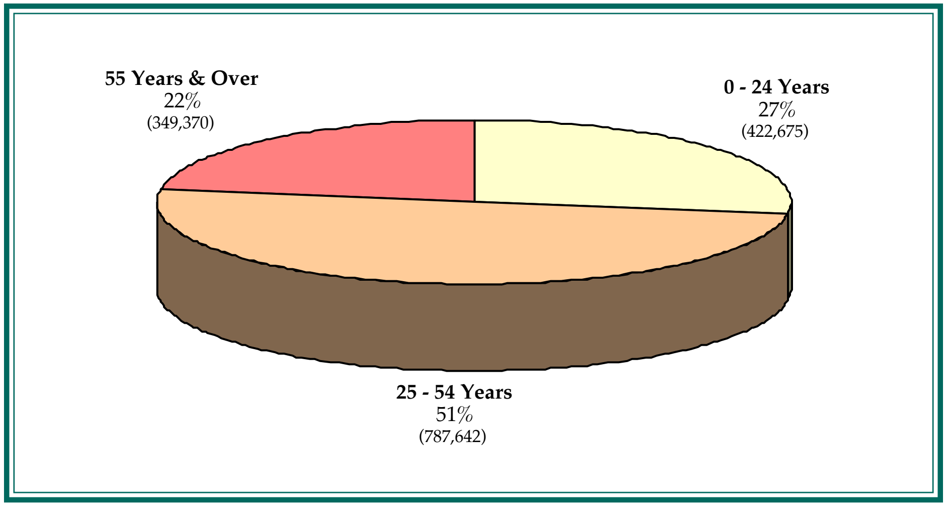



*figure 1.11. Age demographics for Manhattan (New York City). (Source: CACI, 1999 Estimates and Projections)*

## Selecting the Techniques Used for the Study Area Analysis

The project team researched existing studies to help determine what had been studied in-depth and what was lacking in relation to urban forests in commercial districts, so as not to duplicate studies. Although a major portion of the study area consisted of office parks, isolated offices, or isolated manufacturing areas, research identified an excellent study about them by The Urban Land Institute with support by the American Society of Landscape Architects – "Value by Design: Landscape, Site Planning and Amenities". It studied both residential and commercial office parks to qualify the validity that "money spent on landscape design and site planning will provide the developer sufficient financial returns to justify the added cost of development." (Bookout, unknown date) One of the case studies in their report was the Carnegie Center in West Windsor, which was within the US Route 1 corridor of this study. Rather than duplicate ULI's study of office parks, commercial sites were selected for this study where consumers traveled for shopping or overnight stays – retail shopping areas and hotels/motels – based on the types of commercial land use in the region.

The study team looked at various methods for collecting and analyzing data. The Project Advisory Committee helped narrow the potential methods. They suggested that although a Pedestrian Survey in New York City was interesting, it probably would not provide any useful information because researchers would be unable to filter out "the surrounding noise" to determine which activities were related to the street trees and which were not. Although probabilistic gravity model simulations and rent regressions for the area were possible, the project advisors suggested that with limited staff, consultants and funds, other methods could provide more valuable information for the study. They suggested that a follow-up study in the future might be based on this study that considered those applications.

After considering various methods for collecting and analyzing the data, the team selected applications that would accomplish the study's objectives in the most cost-effective and efficient manner, as well as provide useable findings that were quantifiable. The project was broken into three study areas – a regional trend analysis, an image-based valuation survey and local case studies with opinion-oriented and quantitative analyses.

TNJ obtained ESRI ArcView, a GIS software program and several ArcView extensions, including American Forests'CITYgreen and ESRI Image Analysis and Spatial Analyst to identify the study area and quantify the economic values of trees in the region and on selected commercial sites.

In addition to the software, site data was collected from a variety of sources, then input into GIS to create maps, analyze the study area and identify trends *(Part Two)*. Additionally an image-based valuation survey was developed, tested and administered to measure people's shopping preferences for greener retail sites and to measure their willingness to pay more to shop in greener retail areas *(Part Three)*. The final phase of the study analyzed specific commercial sites in both states as a series of case studies *(Part Four)*. The selected sites were studied using opinion-oriented evaluations (personal interviews and written surveys) and quantitative analysis (CITYgreen and UFORE modeling techniques).

## Developing and Distributing Study Materials

Upon completion of each phase of the study, the data was examined and findings were recorded. The results were summarized and recommendations were made in a final report to NUCFAC. Additionally a user-friendly brochure was created with commercial development recommendations. The report and brochure were distributed to TNJ and TNY partners, the study's Project Advisory Committee, NUCFAC, USDAForest Service NE Area Research Station, National Alliance for Community Trees (ACT) members, NJ and NYState Community Forest Councils, NYS DEC Forest Service, NJ DEPForest Service, participating municipalities and business improvement districts, as well as the owners of the sites where the case studies were administered. Information about the study and the materials was posted on TNY and TNJ's web sites: www.treesny.com and www.treesnj.com. Press releases and copies of the report were sent to local media, including the NY Times, NY Daily News, Philadelphia Inquirer, Trenton Times, Home News and Star Ledger.

## Study Conclusions

The study demonstrated that the green infrastructure on commercial sites complemented the site's economic vitality, while it provided regional benefits that improved the quality of life for people living in the area. It also confirmed people's preferences of greener commercial establishments, as well as management's perception of the importance of trees and landscaping in competing with similar establishments for customers or tenants. And finally the study results implied the importance of local ordinances that required preserving forested land during development, installing functional yet aesthetic landscapes on commercial sites, maintaining the on-site landscape elements, replacing trees that were lost during development or redevelopment and/or upgrading the landscape of older developments to meet newly established standards. Ordinances and codes were important, because improvements to the landscape on commercial sites were rarely done voluntarily, unless necessary to compete with neighboring establishments.

The regional trend analysis in *Part Two* identified a steady loss of forest canopy in commercially developing areas in the New Jersey study site over twenty years. It also demonstrated that as trees and forestland in commercially zoned properties were removed, air quality decreased and stormwater runoff increased. Regionally the benefits associated with the preservation and inclusion of trees and forests were significant. The $1.1 million of benefits provided by the trees in 1975 for the removal of air pollutants was reduced to $896,000 in 1995. It was projected that by 2015 the remaining trees and forests would provide only $715,000 for pollution removal.

The benefits of urban forests in the region were undermined as 21% of the forested land cover in the study area was lost to development over twenty years from 1975 to 1995. And 26% of the forested land on parcels designated for commercial land use was lost in the same time period.

The analysis indicated that forest land cover in the study area provided significant air quality benefits to the region and played a crucial role in the management of the region's stormwater. As the trees and forests disappeared for commercial developments, so did the economic benefits that they provided to the region as natural pollutant removers, stormwater run-off reducers and carbon storage mechanisms.

The Image-Based Valuation Survey (IBVS) in *Part Three* of the study corroborated the connection between consumers'shopping preferences and the trees and/or landscaping in shopping areas. While the green amenities in shopping areas were not the most important or only consideration consumers used for selecting where to shop, the green elements – trees and exterior landscaping – were some of the most preferred amenities for their shopping experiences.

Respondents expressed their preferences based on hypothetical situations, using only photographic images as context for making their determinations. The majority of people selected the greener images as their preferred shopping area, whether it was a downtown street, a strip shopping center, or a suburban shopping mall. The greater the disparity of green between the images, the greater the number of people who indicated their preference of the greener image. Respondents were more readily to agree on their least favorite place to shop (low amount of green) when comparing images in a group. Although the architectural style of the malls and shopping centers were important, people tended to select the greener options, even when the less green image had a more modern architectural style. Images with a stylish architectural façade along with a high amount of green elements had the highest selection percent.

More importantly respondents stated a willingness to pay more for their preferences, in this study through a payment mechanism of increased travel time. The majority of people were willing to travel further, thus hypothetically pay more to shop at greener shopping areas when brands, merchandise and cost of goods were the same. Additionally the more clearly images were differentiated, the easier the decision was for the respondent and consequently, the higher the willingness to pay more for the preferred image.

Therefore the IBVS demonstrated that customers preferred greener commercial shopping areas and were willing to pay for this preferred level of green by travelling further to shop in a greener commercial area.

The local case studies highlighted in *Part Four* demonstrated that trees and forestland on commercial sites provided many valuable public benefits to the region – air pollution removal, stormwater runoff reduction and carbon sequestration. These invaluable benefits contributed to the quality of life in the region – noise abatement, better air quality and improved quality of the water in regional watersheds.

Although the two models used – UFORE and CITYgreen – provided varying results for the same case study, they both indicated that a monetary value could be related to some of the measurable benefits provided by trees on commercial sites. The case study results led to the realization that the planting or maintenance of an individual tree was not cost-justified by its quantified benefits alone. Indeed most of the quantified benefits of the trees provided public goods, not directly related to the economic benefit of the owners or managers of the sites.

The study did not prove tangible economic benefits for developers of commercial sites. It implied that some cost savings occurred from preserving forested lands on the site and planting trees throughout the landscape, which reduced the required size of the on-site stormwater management systems. Additionally developers saved money during construction when they preserved forested areas, because the cost for tree removal and site grading was lessened.

Comparison of the air pollution mitigation results provided by CITYgreen and UFORE applied to identical site studies showed relatively good agreement. The widest margin of disagreement between the two models was for the amount of carbon stored by the trees. And there was no comparison for the validity of CITYgreen's stormwater calculations. The findings supported the use of CITYgreen to provide reasonable estimates of air pollution with a relatively low expense of field time and modeling effort.

The local case studies demonstrated the direct correlation between the level of benefits and the total canopy area of both landscape trees and forested areas on commercial sites. The grow-out scenarios indicated in sites where new trees were planted – Lawrence Center, Courtyard by Marriott and 47th Street BID sites – demonstrated the dramatic increase in benefits in the first few decades as young trees grew and matured. A direct relationship to this phenomena was that the larger and healthier the trees were, the more benefits they provided, suggesting the importance of preserving and maintaining larger trees on the site.Additionally those sites with the highest percentage of canopy cover provided the highest level of air pollution and stormwater mitigation benefits to a particular site or region. The forest patches preserved on the South Brunswick Square, Lawrence Center and Bryant Park BID sites contributed the majority of the benefits that the sites provided. Thus it was evident that the preservation of forested areas, as well as long-term maintenance to sustain landscape and street trees yielded the greatest overall benefits.

Because of the vast amounts of hardscape on the sites – city street, parking lots and interior roadways – researchers were disappointed that the cooling effects of tree shading and evapotranspirational cooling by landscaped areas could not be calculated by either of the models. Literature reviews of NASAstudies showed that cooling and shading in parking lots was believed to have benefits related to human comfort (reduced thermal stress) and reduced VOC losses (resting losses) from vehicles. These studies correlated the effects that tree planting had in cooling heat islands, which also reduced smog formation and resulted in air quality improvements on a regional scale.

The case studies also measured people's perceptions about trees and landscaping on commercial sites. The qualitative responses from anecdotal interviews demonstrated that people recognized the value of trees and landscaping on commercial sites. Business managers understood that the amount, type and condition of green infrastructure on their site or neighboring sites related to their commercial success or failure. Additionally they felt that people associated well-maintained landscape elements to a well-maintained business. Although they acknowledged costs for installation and maintenance, they felt the benefits outweighed the costs.

Managers realized that although the green infrastructure on a site contributed to the performance of a commercial establishment or business district, the quality of the landscape would not make up for the lack of other elements necessary for its success, such as location, access, parking, service, personnel or product.

Management helped make some of the decisions about the level of green infrastructure on their sites by knowing the competition and hiring professionals who would help them reflect or exceed the level of greening on surrounding sites. The greatest influence on the level of green infrastructure were the professional landscape architects and/or engineers involved in the development or redevelopment plans, governmental ordinances and regulations, physical and mechanical site constraints, as well as the knowledge, involvement and commitment of the municipal planning staff and its local decision makers – elected officials and planning or zoning boards. Commercial establishments abided by local ordinances and requests, usually without question, to maintain good relationships within the city – part of doing good business.

Although the scientific models used in the study did not allow researchers to precisely quantify all of the benefits that the trees and forestland provided, the study's findings suggested that trees and landscape on urban and suburban commercial sites provided benefits and values to many parties.

For commercial developers, the trees, forests and other landscape elements:

- helped them win the support of local decision-makers for proposed projects;
- gave them a competitive edge in obtaining tenants or buyers;
- helped them save money when they preserved existing trees and planted new trees, because it lowered the size and costs for their on-site stormwater management systems;
- decreased development costs by preserving existing forestlands on site, which minimized the number of trees removed and/or the amount of site grading required;
- increased the long-term value of a project, which could make potential investors feel more secure with their investment; and
- translated into increased financial returns.

For managers/owners of commercial establishments or business improvement districts, the green infrastructure:

- helped them achieve greater market identity;
- differentiated them from similar establishments or business districts;
- provided a first and lasting impression with customers and guests;
- attracted tenants/merchants and customers/guests;
- assisted them in competing with neighboring or similar types of establishments;
- helped define traffic patterns to ease pedestrian and vehicular circulation; and
- encouraged neighboring sites to upgrade their landscape, thus starting a movement that improved a larger area.

For tenants and merchants in cities or suburbs the trees and other landscape elements:

- influenced their decision to buy or rent in that commercial market;
- helped them establish a distinctive image or sense of place;
- attracted customers/guests;
- made them more competitive with businesses that were similar to theirs; and
- created more comfortable surroundings that encouraged people to stay longer and return to the site, which translated into better financial returns.

For customers and guests, the trees and landscaping on commercial sites:

- contributed to their sense of security and safety;

- created a human scale, especially desired when they were near tall buildings, massive walls or in vast parking lots; and

- created comfortable surroundings where they could shop or relax.

For the municipality and region where the commercial development was located, the green infrastructure:

- contributed to a community's sense of place;

- mitigated the impact of commercial developments (noise, lights, impervious surfaces and traffic) constructed near residential neighborhoods through vegetative buffers;

- provided an attractive commercial setting that encouraged neighboring commercial sites to upgrade their landscapes;

- provided commercial services to residents;

- contributed to the residents' morale, community spirit and pride;

- improved air quality by removing air pollutants and storing carbon;

- conserved energy by shading buildings and hardscape thus lowering the ambient air temperature during seasonally hot times or buffering buildings from winter winds;

- decreased the amount of stormwater runoff discharged into waterways, which improved the water quality; and

- could act as a greenway to link open space or parklands that were separated by commercial developments.

In conclusion, the information and data gleaned from the three sections of this study suggested that green infrastructure on commercial sites contributed substantially to the quality of life in the region by providing environmental benefits (as quantified and valued by two scientific models), was perceived as a good investment for urban and suburban commercial developments (as expressed in anecdotal interviews) and was preferred by the general public (as indicated by an image-based valuation survey).

## Study Recommendations

The study indicated a trend in tree and forest loss as commercial areas were developed. Does this trend have to continue as commercial development continues along the busy corridors in this flourishing region or in similar areas undergoing development booms? Trees and forested land protect the public health, safety, general welfare, as well as the aesthetics of a region and its communities. All of its citizens enjoy the multitude of benefits directly attributed to the trees. Therefore the diverse benefits associated with the planting and preservation of trees and forests should be considered in the land-use planning process, as well as during the site planning process for both residential and commercial developments. These recommendations are not anti-development. Rather, they unite regional quality of life issues with local development issues. This harmonious approach can encourage commercial developments that will not diminish the quality of life, but enhance it.

The tree cover in the commercial districts of older cities was also dwindling. Researchers were unable to develop any trends of tree loss or gain in New York City's business districts, but literature reviews supported the hypothesis of urban tree loss. The tree loss in commercial districts was the result of:

- a dying older tree resource that was not being replanted;

- insufficient funds for tree maintenance except when considered a hazard;

- the spread of diseases because of the homogenous selections of tree species in large areas;

- vandalism by people who did not respect their beauty and strength;

- street tree removals by uninformed landlords, residents or merchants who did not understand or appreciate the benefits that the trees provided; and

- lack of city codes requiring planting and care of trees in commercial districts.

Although the study indicated that developers and management of commercial sites recognized the importance of trees and landscape elements in competing and obtaining financial success, the level of investment in the green infrastructure was directly related to the landscape standards set by the municipalities or surrounding business districts. Some municipal decision-makers and some professionals thought that tree preservation, tree replacement and other landscape ordinances placed unnecessary encumbrances on developers, which hindered development in their region. Instead well-informed developers and their site managers appreciated the value of quality landscapes, as they helped them compete with other commercial establishments for tenants and customers. They comprehended that the first views of a commercial site, as well as the experiences that shoppers experienced while driving through a site, parking, accessing public transportation or walking to store entrances influenced shoppers' expectations of the type of commercial establishment that awaited them inside. Consumers' outdoor experiences were imprinted in their memories, along with their inside experiences, which helped them determine if they would return to a commercial site and how often they would return to it.

The following recommendations are suggested ways that may help increase or maintain the current level of green infrastructure or at a minimum reduce the amount of tree and forest losses, while encouraging sound commercial development and redevelopment in a region.

- Educate commercial developers that the green infrastructure on commercial sites makes good business sense – it helps them achieve a market identity; it differentiates them from similar businesses or business districts; tenants, merchants, shoppers and guests prefer greener sites; vacancy rates are lower in shopping centers and business districts that are greener; it promotes good will in the community; and quality landscapes give them a competitive edge when competing with similar types of commercial establishments.

- Educate local decision-makers (BID Directors, City Councils, Planning/Zoning Board members, Environmental or Shade Tree Commissions/Boards, Parks Department staff, etc.) that the green infrastructure on commercial sites contributes substantially to the quality of life in the region by improving air and water quality, cooling heat islands, conserving energy, preserving the cultural and historical landscape, creating beauty, attracting businesses and creating a sense of place.

- Hire competent municipal staff and consulting professionals who will be working with the planning, inspection or enforcement of commercial site development plans. They must be required to uphold the standards set by the community that link the significance of green elements on commercial sites to the quality of life in the community.

- Develop a local parks and recreation, environmental or shade tree committee/commission/board to evaluate local ordinances (tree, landscape and open space), community forest plans and proposed landscape plans for commercial and residential developments. Depending upon the needs of the community and the authority given, they could also implement planting and care projects, provide educational outreach efforts, organize park and street tree inventories, provide recommendations for upgrading community forest plans and tree protection, tree replacement or other landscape ordinances.

- Develop inter-municipal/regional partnerships (regional community forest organizations, planning partnerships, land trusts, etc.) that evaluate existing forestland, determine its value to the region and establish guidelines for its development, preservation and protection, especially in areas along municipal or county boundaries.

- Develop business improvement districts (BIDs) in urban commercial areas that encourage and support planting and maintenance projects. Encourage partnerships (landscape committees, etc.) between adjacent neighborhood associations, business districts or merchants to evaluate their street trees, parks and landscape elements; establish guidelines for protecting and improving the green infrastructure within them; and look for solutions in providing transitions between them. In areas where a BID status is not granted, a downtown chamber of commerce or a local business association can form committees (landscape, tree, beautification, etc.) that focus on greening issues in their neighborhood and partner with groups from neighboring districts to solve them.

- Encourage volunteer involvement in planting, providing care/maintenance and assessing the state of the trees in municipalities or business districts. Organized citizen action groups with trained volunteers that are committed to protecting the trees and urban forests are quite successful in providing for the long-term. As elected officials change, so could their commitment to tree-related issues. But an active non-governmental community forest group can keep greening issues in focus, provide support to local governmental commissions and departments that often have inadequate staff and funds, as well as raise money for specific greening projects without being bogged down with governmental constraints. Do not overlook professionals residing in a community or neighborhood. They often are interested in giving back to their community and will volunteer their expertise to help improve its quality of life. Informal groups of merchants and neighboring residents, along with organized youth, civic, religious or non-profit groups can also be invited to volunteer in greening activities as a way to display their community pride.

- Establish ordinances that reflect local values by promoting trees and forests as invaluable parts of the infrastructure in commercial districts, not as extravagant frills. Regulations and policies should encourage developers and property owners to protect and sustain trees and urban forests and meet or exceed the standards for planting new trees and creating landscapes for commercial development/redevelopment projects. Establish landscaping standards for planting in commercial districts based upon type, size and location of the development. Higher standards for commercial developments will attract commercial developers with high standards – ones that are willing to work with the community and improve the surroundings for its employees, its customers and the local residents. Quality commercial districts are one element that creates healthy, picturesque communities.

- Establish ordinances that facilitate the preservation of healthy or significant trees and forests and the retention of large areas of naturally forested land whenever possible during development. Leave the naturally occurring ground cover and understory vegetation in tree preservation areas unless they are undesirable or invasive species. Prevent clear cutting and mass grading of land that results in the loss of mature trees. The protection of existing trees and forests provides a bigger impact to the environment than planting new trees. Set standards for assessing the value of existing trees and forested areas based on their significance to the area (culturally or aesthetically), their function (street tree, riparian buffer, valuable wetland, land use transition, greenway connection, wildlife shelter, etc.) and their quality (health, size, species of trees and understory vegetation, etc.). Then establish methods to protect those that are most valuable to the community or region.

- Require tree protection plans during construction. Use evaluation and approval processes that are similar to those required for soil erosion and sediment control plans during site construction. Establish methods and standards for tree/forest protection during the construction process, as well as replacement methods for those lost or damaged due to negligent construction, accidents or the adverse impact years later from the damage of the trees' root systems. All tree-save areas and tree protection measures should be identified, reviewed and approved prior to any land disturbances. The preserved trees should be observed for three to five years after construction is completed to determine if there were any damages that resulted from improper practices by the contractors.

- Facilitate the replacement of healthy or significant trees and forests that are removed on sites undergoing development or redevelopment. Establish forest replacement standards based on the quantity, size and species of healthy or significant (historical, unique or large) trees that will be removed or based upon the type of land cover, size of the area and density of forestland that will be removed. Acceptable replacement standards should address the quantity, size (in caliper or dbh), density and species of trees; spacing of plants; types of understory plantings; mix of understory, canopy, deciduous and evergreen trees (maximum percentages for each); species mix (maximum percentage for one species or genera); and approved replacement planting locations on or off-site for replacement trees and forests. The methods for calculating the amount of trees to be replanted can be set at 1:1 for replacing some trees and forests, while the amounts for other locations or types of trees and forests can be set at more or less based upon a community's values and needs. It can also be based on the number of acres and density of trees per acre that were removed, rather than an actual number of trees removed.

- Develop lists of preferred trees and/or unacceptable trees for reforestation efforts. With input from professionals (landscape architects, foresters, arborists, ecologists, etc.) establish tree selection lists (native and/or ornamental) for specific types of sites or plant communities, as well as where they can be planted within a municipality. Establish a maximum acceptable percentage for a single species within areas of designated sizes. Tree diversity helps to prevent monocultures that could promote the decimation of an area by disease or insects. Many of the factors that should be taken into account when selecting trees cannot be addressed in lists, but they should be considered in the selection process on a case by case basis – the trees' functions on the site, the overhead and underground physical constraints and the size of the space where the trees will be planted. If ozone and air pollution are problems in the region, select species with no or low VOC emissions as preferred replacement plantings. But consider that many high VOC-emitting trees are also those that are most urban tolerant. Use tree lists as guidelines. Evaluate and update them periodically.

- Establish off-site reforestation agreements when trees are removed during construction. If trees cannot be planted on site and/or there is an insufficient common area for replanting within a municipality, the balance of trees could be accepted for a tree banking program with terms set as to where, when and how many trees will be planted in the region.

- Establish a connection between reforestation requirements and open space planning efforts. When developers remove valuable forested lands from commercially-zoned properties, allow them to offset this loss by contributing to an open space fund to purchase a piece of forested land indicated on an open space plan that is at least of an equal value or size as to that being removed on the developed site. Funds pooled together from developers would be used to purchase valuable forestland that a county or community wants to preserve, then the land would be dedicated back to the county or municipality for long-term open space preservation.

- Establish planting standards for street tree planting in commercial districts taking into consideration potential overhead and underground site constraints.

- Encourage developers to create innovative site plans and landscape designs that complement a site's natural conditions – topography, woodlands, drainage, solar orientations, vegetation, water bodies and views – and promote the preservation of existing natural features. By preserving trees and forests on their sites developers can receive tangible benefits – reduced construction costs from building smaller on-site stormwater management systems, removing fewer trees and/or grading smaller portions of the site.

- Raise the minimum standards for the number of trees in parking lots to provide sufficient plantings within large areas of paving and to rid communities of asphalt seas. Encourage attractive resourceful solutions for functional parking lot designs that use vegetation to shade the pavement, buildings, vehicles and pedestrians, buffer the views of parked cars from surrounding neighborhoods and streets and reduce the amount of stormwater runoff. Grant variances to reduce the required amount of parking spaces to preserve significant or specimen trees that would otherwise be lost if requirements were strictly applied. These winning efforts will work toward improving the quality of life in a community by reducing the ambient air temperature on hot days, conserving energy on surrounding buildings and reducing air pollution from heated parked vehicles and vehicle exhaust.

- Require vegetative buffers between commercial properties or as transition areas between different types of land use, especially between residential and commercial zones. Promote the use of vegetative buffers along the perimeter of sites that characterize the existing area's cultural landscape experience. Buffers mitigate the light and noise pollution and increased traffic caused by commercial development near residential areas. Encourage the preservation of existing forestlands, because natural buffers are better at effortlessly decreasing the possibility of flooding and improving water quality by reducing stormwater runoff.

- Require commercial sites to meet or exceed minimum standards for landscaping or trees planting when undergoing site renovations and upgrades. Landscapes of older developments are often well below new standards and voluntary landscape upgrades usually occur only when the management determines they are losing customers or tenants to a competitor.

- Establish incentives or other ideas to entice older commercial developments to upgrade their landscape within a reasonable length of time to meet or exceed any new standards.

- Establish standards for maintaining park and street trees (publicly owned) in downtown commercial districts, parking lot and landscape trees (privately owned) on commercial sites and other significant or historical trees in commercial districts. Develop methods for assessing the health of trees in commercial districts; identify who will be responsible for their assessment and maintenance; and determine the length of time they have to comply after reports of hazardous trees. Require the maintenance of newly planted trees for one to two growing seasons after the date of final inspection. Property owners must maintain the density of tree planting on site and replace any trees that die or are removed. They may be planted on or off-site.

- Establish enforcement policies and procedures for complying with landscape ordinances, along with the associated penalties for violations or noncompliance.

- Reveal sources for obtaining trees (e.g. NYC Parks Department will supply them to BIDs and others who request them) and grants (e.g. state forestry departments offer grants for planting trees, providing care or developing community forest plans).

- Recognize the efforts of commercial developers who respected the community's values for green commercial districts and exceeded the minimum standards or developed an innovative solutions during development or redevelopment projects.

# REGIONAL Trends ANALYSIS

### Regional Trends Summary

Over the years there has been a steady loss of forest cover in commercially zoned suburban areas, as well as in downtown urban areas. This phase of the study examined the trends of forest loss in commercial districts within the region and sought to quantify the public and private benefits of these forests. This was accomplished through the use of UFORE, a scientific model developed by the USDAForest Service (USFS) and CITYgreen, a widely-used Geographic Information Systems (GIS) software tool developed by American Forests that incorporates algorithms from the USFS UFORE models and USDA Natural Resources Conservation Service (NRCS) TR-55 Stormwater model.

Because of the unavailability of historical data for New York City, no trends could be established or analyzed, although an overall loss had been projected. The regional trend analysis considered the benefits of trees within the New Jersey study area (the US Route 1 corridor from Trenton to New Brunswick) and studied the change in forest cover over a twenty-year period. Based upon the identified trend of urban forest loss, the data was projected twenty years into the future. The regional tree benefits were calculated over forty years, using the assumption that the trend continued at the same rate of urban forest loss.

The methodology used in analyzing the regional trends for the US Route 1 study area was successful in meeting its stated objectives and indicated a steady loss in forest cover from 1975 to 1995 along the corridor, an area where both residential and commercial development continues to this day.

If developers and municipalities fail to see the value that forested land provides to the region, as well as the local communities, then the loss of valuable forestland will continue until the degradation is beyond repair. Municipalities need to strengthen their land planning and site planning/landscape ordinances by addressing forested land cover issues better. Developers need to consider how their actions during the development process will effect the well being of the community, without the fear that it will harm their economic success. Developers and municipal decision-makers can work together to create a successful commercial development, while not harming the quality of life for the people who work, shop or live near the commercial sites.

### Regional Trends Hypotheses

The trend hypothesized for the region was that valuable urban forests on commercially zoned properties, as well as residentially zoned properties, were being lost as new developments emerged in suburban areas. Although unsure of the tree loss rate, it was assumed that the loss would be greatest in those areas where development was on the rise. It was also hypothesized that as the urban forest cover decreased, the economic benefits for the public good also declined.

### Regional Trends Objectives

The objectives of this part of the study were

- to analyze the regional trends of tree and urban forest loss or gain from commercial development and redevelopment; and
- to scientifically quantify the tangible benefits of trees and urban forests within commercial districts on a regional scale, using Geographic Information System (GIS) analysis techniques and existing scientific models

### Regional Trends Methodologies Background

The growth and ease-of-use of Geographic Information Systems (GIS) provided a powerful platform on which to locate and identify specific parcels of lands, analyze parcels based on their nature, function or relationship to other parcels and model the physical systems. Tree-related benefits were measured in the ArcView GIS environment using models developed by the USDANRCS (TR – 55 Stormwater model) and USFS (UFORE) and software developed by American Forests (CITYgreen).

Various quantifiable benefits have been associated with trees and urban forests. Scientific models identified and analyzed the environmental benefits of these forests, such as air pollution and stormwater runoff mitigation and the protection of soil resources and wildlife habitat. Additionally the physical ability of trees to provide shade, absorb ultraviolet light and transpire influenced climate and air quality. These effects and more were studied and quantified both empirically and through the use of models.

### UFORE: A Scientific Modeling Program

UFORE was one of the modeling techniques considered for the regional analysis, as well as the local case studies. "The Urban Forest Effects (UFORE) computer model quantifies species composition and diversity, diameter distribution, tree density and health, leaf area, leaf biomass and other structural characteristics; hourly volatile organic compound emissions (emissions that contribute to ozone formation) throughout a year; total carbon stored and net carbon sequestered annually; and hourly pollution removal by the urban forest." (USDAForest Service, date unknown)

The UFORE model was developed by D.J. Nowak, E.G. McPherson, R.A. Rowntree and others, throughout the 1990s, but was based on work dating from the 1980s. The model's results were cross-checked and verified against test data sets and field measurements. The UFORE models were not yet in a user-friendly format, however some computer-savvy users were using it. Currently data was collected at a site and then sent to the USFS for analysis. It was the developers' goal to make it user-friendly and freely distributed in the future. The USFS published studies using the UFORE model in New York, NY; Brooklyn, NY; Atlanta, GA; and Baltimore, MD.

Because UFORE always required tree-specific data, it could not generate data for tree stands or forest patches that were not specifically inventoried. Therefore it was not practical to use UFORE for the regional analysis, only the local case studies. However CITYgreen used various UFORE models in its computations.

## CITYgreen: GIS Modeling Software

American Forest's CITYgreen software operated in a GIS environment as an extension to ESRI ArcView, the industry standard for desktop GIS. It was used to facilitate the modeling of various tree-related benefits. The models used within the CITYgreen software were generally adapted from the NRCS TR-55 and USFS UFORE models, as well as from other research used in the development of those models. In general, CITYgreen relied on simplified assumptions and generalized inputs so that the product was widely used by people with little knowledge of modeling and with minimum input data requirements. By contrast UFORE used site specific inputs (e.g. meteorological and air pollution data actually collected within the region) and was able to generate more accurate results.

CITYgreen accepted generalized factors for forest composition in its analysis of forest patches or suggested simple extrapolations of local analysis to regional scales. These extrapolations allowed researchers to study wooded areas without measuring each tree, but could have caused a multiplication of errors effect if the assumptions were incorrect. Finally CITYgreen was adapted to allow the estimation of carbon storage and sequestration, air pollution mitigation and stormwater runoff reduction over the entire study area based on the various land-cover types.

CITYgreen was a readily accessible software package and provided generalized estimates. It was becoming popular because of its ease of use with minimal inputs, the minimal processing time required, its ability to estimate regional benefits and the colorful maps it created. Published studies by American Forest using CITYgreen included such places as Austin, TX, Atlanta, GA and Dade County (Miami area), FL.

## Regional Trends Methodology

Because land cover types directly related to air-quality, groundwater and surface-water quality within the region, the change in land cover within the US Route 1 study area, specifically forest cover, was examined over a twenty year span, then projected twenty years into the future.

## Site Selection Process

In New York City the major element of the urban forest in our study areas was the street tree. Researchers were unable to locate any historical aerial photographs that were at a resolution where the presence or absence of individual street trees could be determined. The selected BIDs and the NYC Department of Parks and Recreation (DPR) were also unable to provide any historical data that could be used to identify any trends of tree loss or gain. The overall tracking of street trees in NYC was not maintained until the last few years and then it only tracked newly planted trees, not removals or losses. Periodic tree surveys by NYC DPR indicated an overall loss of tree canopy in the city, but without maps, photographs or recorded data, researchers were unable to analyze the urban forest trends in New York City or make future projections for this part of the study.

Therefore the US Route 1 corridor area in New Jersey was the only area selected for the regional analysis of the urban forest growth/loss trends. The identified New Jersey region was an area where new commercial and residential development was occurring that effected the loss of stands of forests and historical data was available that illustrated the green infrastructure of this area over a 20 year period. The New Jersey study area along the US Route 1 corridor contained a fair cross-section of rapidly growing suburban areas bounded on either end by old cities. *Part One* of the study indicated the diversity of ages, income and races within the study area. The study area had a wide range of commercial environments and a high percent of commercially zoned land, which was also described in detail in *Part One*.

The New Jersey study area needed to be strictly defined for the purposes of a GIS analysis. In the first attempt to define this study area, only sites were selected that abutted the highway, giving the region an irregularly defined outer edge. The team looked at this awkwardly defined area, noted how property lines changed over time and decided to identify the region by establishing a determined width to analyze the sites along US Route 1. As parcel mapping was obtained and digitized, it was apparent that the extent of most commercial properties directly associated with US Route 1 fell within a 2,000-foot buffer on either side of the highway and thus this buffer was set as the study limits.

## Site Description

The New Jersey study area followed along the busy US Route 1 corridor and covered 12,037 acres with 45% commercially developed, 24% residentially developed and 31% undeveloped. The selected area was bounded on either end by two older cities, both established in the 1600s. The area in-between consisted of farmlands and woodlands, but had been the product of suburban development – largely commercial development – with the largest boost occurring over the last twenty years.

The area included six municipalities within Mercer County – City of Trenton, Ewing Township, Hamilton Township, Lawrence Township, Princeton Township, West Windsor Township and six municipalities within Middlesex County – Plainsboro Township, South Brunswick Township, North Brunswick Township, East Brunswick Township, Milltown Borough, City of New Brunswick. The small portions of Milltown Borough, East Brunswick Township, Princeton Township and Hamilton Township impinged by the study area buffer consisted only of undeveloped, residential or water-covered areas and therefore were not of significant concern to this study. The small part of Ewing Township within the study area had similar zoning and land-use characteristics as the part of Lawrence Township that lay adjacent on the opposite side of US Route 1, and so it was included along with Lawrence Township.

## Data Collection

The GIS process for analyzing the regional trends used land-cover (specifically forest cover), parcel, zoning and political boundary themes. Before modeling and analysis was done, the required data was identified, then collected or developed. ESRI Image Analysis and Spatial Analyst were used to manipulate imagery from available aerial photos, as well as for the classification of the land use and land cover in the study area. The data collected for the regional GIS analysis of the US Route 1 corridor study in New Jersey consisted of the following:

- Political Boundaries (County and Municipal)
- Roads
- Land Cover – Sequential, Land Use, Zoning, Parcel Boundaries and Attributes, Aerial and/or Satellite Imagery
- Tree Inventory Data
- Soils and Topographic Data

The following sources were thoroughly reviewed for existing suitable electronic data to use in the study:

- New Jersey Department of Environmental Protection (NJ DEP)
- New Jersey Geological Survey (NJGS)
- United States Geological Survey (USGS)
- Federal Spatial Data Clearinghouse
- Mercer and Middlesex County Planning Boards
- USDAForest Service
- Municipal Offices (tax assessor, planning and engineering departments)
- New Jersey Non-Government Organization (NGO) GIS Users Group
- Rutgers Center for Remote Sensing and Spatial Analysis (CRSSA)

The NJ DEPprovided digital GIS data layers (themes) of political boundaries, combined land-use/land-cover (1986 basis), soils and roads, along with 1995/1997 digital aerial color orthophotography – aerial photography that was spatially corrected for distortion resulting from camera angle and elevation changes. Digital graphic files of USGS topographic quadrangles were obtained directly from the USGS. Data that was not readily available was developed, including parcel level (cadastral) data, zoning and land-cover.

*Parcel-Level Data Development*: With the exception of West Windsor, it was necessary to develop digital parcel-level data from each municipality within the New Jersey study area. Parcel layers showing commercial parcels, residential and undeveloped areas were manually digitized into GIS through the use of tax maps (generally paper), zoning maps, recent aerial photography and field survey.

Contiguous residential parcels were grouped together with no further categorization. Undeveloped lands were sub-classified into Forested, Agricultural, or Altered (vacant, barren or disturbed). Commercial parcels were separated into the following categories (figure 2.01):

- Isolated Commercial Establishment (200 ± sites)
- Commercial Strip Development (10)
- Shopping Center (10)
- Mall (2)
- Hotel/Motel (20)
- Isolated Office Building (29)
- Office Park (20)
- Isolated Manufacturing or Industrial Building (46)
- Manufacturing/Industrial Park (1)
- Institutional (Police, Fire, Library, Church, etc.) (18)
- Transportation/Utility/Communication corridors or centers (24)
- Research (2)
- Other Commercial – mostly mixed-use neighborhood commercial

*Land Cover Data Development:* Several approaches were taken to develop suitable and consistent land-cover themes (layers) for several successive time intervals for analysis through GIS. A search of available land cover data failed to identify suitable themes for direct analysis, however several available NJDEP sources served as a later reference.

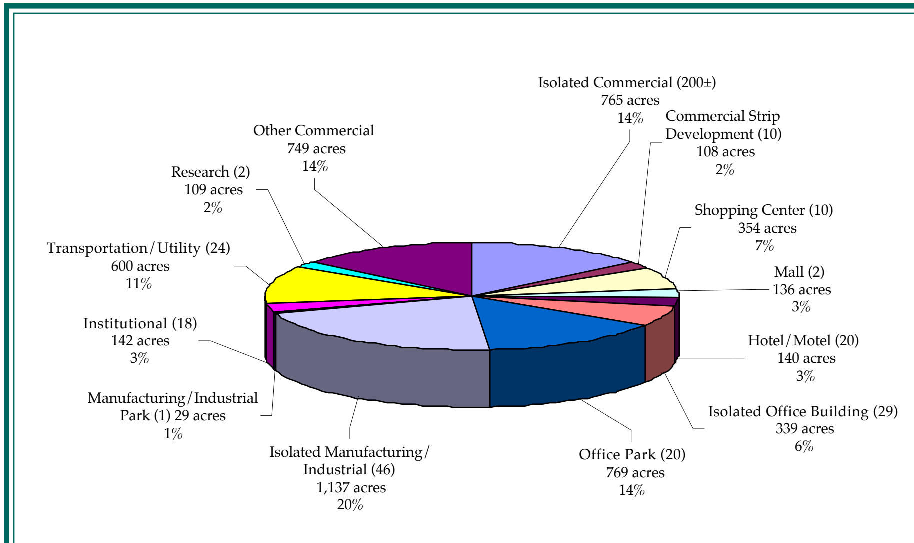



*figure 2.01. Types of commercial land use in New Jersey along US Route 1 corridor study area. (Does not include the City of Trenton)*

Attempts were made to use remote sensing techniques to classify aerial or satellite imagery of the study area collected at several intervals. Satellite imagery proved to be of too low spatial resolution for this relatively small study area. Digital, ortho-rectified color-infrared aerial photography taken during 1995 and 1997 was used extensively throughout this study, however similar format imagery from earlier years could not be located. The fact that this photography, as most aerial photography, was taken during times of the year when deciduous foliage was not present ("leaf off") made it difficult or impossible to use supervised or unsupervised land-cover classification algorithms to develop forest-cover themes.

Manual classification and digitization was used to develop a sequence of consistent classified land cover themes or layers of the study area. Hard-copy black and white aerial photography (1"=400'scale) of the study area was obtained from the planning boards of Mercer and Middlesex Counties. Mercer County photography was obtained for the years 1975, 1985 and 1995, while Middlesex County photography was for 1974, 1987 and 1998. Photography from the mid-1970's and mid -1980's was scanned, imported into GIS and rectified. This imagery along with the NJDEPimagery from the mid-1990's served as a basis for on-screen digitizing. For consistency a single person conducted the interpretation and digitizing. The following land cover layers were defined for the regional analysis: forest, agriculture, water and urban.

The areas digitized as urban contained trees that were not readily included into the areas digitized as Forest land cover. These included individual trees, small stands of urban forest and forested buffers. To account for these trees, a random point analysis was performed on the study area. Using a random point generating function script in ArcView, 1,000 random points were laid over the orthophotography of the study area. Each point was then assigned an appropriate land cover classification of forest, grass, artificial (impervious), cropland, barren or water. Estimations were made from these random points on the distribution of land cover types within the various subsets of the study area (i.e. commercial areas, urban areas, etc.).

## Quantification of Urban Forest Benefits

After the data was collected and digitized, the analysis was performed. Only CITYgreen was used for the regional analysis of the NJ study area, because the UFORE models required representative individual tree data for their analysis. CITYgreen allowed the inclusion of larger naturally forested areas that were difficult to inventory on an individual tree basis.

Using the designated land cover types, CITYgreen estimated the amounts and values of carbon storage and sequestration, air pollution mitigation and stormwater runoff reduction for the entire New Jersey study area. Although the CITYgreen software can estimate energy conservation, it can only do so when the trees are within 35 feet of any one or two-story buildings. This measurement was considered unsuitable for use at most of the sites within the study and therefore was not used within the regional analysis. Although the CITYgreen program also estimates wildlife benefits, they were not modeled during this study at either the regional or local analysis, as no monetary value could be assigned for their value to commercial districts.

The following benefits were quantified for the regional analysis using the CITYgreen software.

- *Carbon Storage Capacity* – A measure based on the UFORE-C module, of the amount of carbon stored within the tree's biomass from the removal of atmospheric carbon dioxide, a greenhouse gas.

- *Carbon Sequestration Rate* – The rate that trees process carbon for storage based on the UFORE-C model.

- *Air Pollution Removal Rates* – The annual air pollution removal rate, based on UFORE-D calculations, of trees within the study area were estimated for Nitrogen Dioxide ($NO_2$), Sulfur Dioxide ($SO_2$), Ozone ($O_3$), Carbon Monoxide (CO) and Particulate Matter less than 10 microns (PM10), using UFORE-D models. UFORE estimated the amount of pollution being deposited within a given site based on weather and pollution data collected from the nearest local station monitored by the NJ DEP– Newark, NJ. Because researchers used CITYgreen, rather than UFORE, these estimations were calculated using more generalized annual meteorological and air pollution deposition factors. Calculations for the New Jersey sites were made based on the average of this generalized data for eight cities from across the nation that were listed in CITYgreen's database. It then calculated the removal rate based on the area of the canopy coverage in the region. The monetary value of pollution removal by trees was estimated using median externality values for the United States for each pollutant. These monetary values were developed by state and federal environmental agencies as a means to quantify the net cost to society of a given amount of air pollutant emitted.

- *Stormwater Runoff Reduction Rates* – Using algorithms based on the USDA TR-55 stormwater models, CITYgreen quantified how land cover, soil type, slope and precipitation affected stormwater runoff volume, time of runoff concentration and runoff peak flows within the region. The USDATR-55 model used land cover types, not just forest cover to determine the effects. It calculated the volume of runoff that would need to be contained by stormwater retention basins if the vegetation were removed. For the New Jersey study area stormwater runoff estimates were based on a two-year, 24-hour storm event as recommended in the CITYgreen modeling documentation. A 3.5-inch storm event was used to calculate the volume of stormwater runoff. The resulting product was the amount of water that would be considered as runoff if 3.5 inches of rain fell during a 24-hour period with the balance being assimilated into the environment. Using current published cost figures for the construction of stormwater management facilities (stormwater basins and associated structures), a monetary connection was drawn based on the ability of tree cover to mitigate stormwater management requirements.

The general stormwater management system estimation cost figures were obtained from data published by MEANS and NJ DEP/US EPA. They were factored to reflect 1999 dollar-values using standard inflation factors. The calculated value seemed to only be meaningful in scenarios where there was no stormwater management on the site, usually an undeveloped site. For example by protecting forested areas on a site prior to development or by planting vegetation, more specifically trees during development, the costs of designing and building stormwater management facilities on the site would be less. Although there was a slight relationship, trees planted in parking lots seemed to have an insignificant effect on stormwater runoff. More seemed to depend upon what was underneath the tree canopy and how the trees were planted in the lots, rather than just the presence of trees in the lots. For example some considerations that effected stormwater would be whether curbs were around tree pits or landscaped areas or whether the planting area was mounded, flat or sunken.

## Regional Trends Findings

The final step in the process was to analyze the resulting data and identify any trends that supported or countered our hypotheses. The methodology used in analyzing the regional trends for the US Route 1 study area was successful in meeting its stated objectives – defining regional trends in forest cover loss and projecting them into the future, as well as quantifying the economic benefits of forest cover within the region.

In 1995 only 31% of the 12,037-acre study area was undeveloped. Forestland covered 4,114 acres (34%) of the study area. Just over half of the forested land cover was on undeveloped parcels and 29% was on parcels identified as commercial land use. 58% of the study area was zoned for commercial development and this land contributed to 51% of the area's forest cover. (figure 2.02)

| NJ Study Area by Land Use in 1995 | Entire Study Area | Commercial Land Use Areas | Residential Land Use Areas | Undeveloped Land Use Areas | Commercially Zoned Land Use Areas |
|---|---|---|---|---|---|
| Total Area (acres) | 12,037 | 5,373 | 2,903 | 3,761 | 6,935 |
| % Land Use within Study Area | 100.0% | 44.6% | 24.1% | 31.2% | 57.6% |
| Forest Cover Area (acres) | 4,114 | 1,211 | 699 | 2,204 | 2,105 |
| % Forest Cover per Land Use Area | 34.2% | 22.5% | 24.1% | 58.6% | 30.4% |
| % of Study Area's Forest Cover | 100.0% | 29.4% | 17.0% | 53.6% | 51.2% |

*figure 2.02*

The results from the analysis of historical aerial photographs substantiated the hypothesis that there was a steady loss in forest cover from 1975 to 1995 in the corridor study area. In 1975 43% of the 12,037-acre study area was forested (5,157 acres) and by 1995 only 34% of it was. Over twenty years 1,043 acres of forest cover was lost in the study area, which equated to about 52 acres lost per year. (figure 2.03)

In 1995 45% of the study area was commercial properties (5,373 acres). The parcels identified as commercial land use in 1995 were analyzed for the amounts of forest cover that were present in 1975 and 1985. This indicated the amount of tree loss due to commercial development. In 1975 1,641 acres of the defined commercial areas were forested, but by 1995 only 1,211 acres were forested, indicating a loss of 431 acres of forest in twenty years. The forest cover losses for commercial land use in the study area were approximately 14% in the first ten years and 26% over the entire twenty years. (figure 2.04)

| FOREST LAND in US ROUTE1 CORRIDOR STUDY AREA (New Jersey Sites without Trenton Area) — Forest Cover | 1975 (in acres) | 1985 (in acres) | 1995 (in acres) |
|---|---|---|---|
| Forested Land in Total Study Area | 5,156.6 | 4,622.1 | 4,113.7 |
| Forested Land in Commercial Land Use Areas | 1,641.1 | 1,414.0 | 1,210.5 |
| Forested Land in Residential Land Use Areas | 1,266.5 | 950.5 | 698.6 |
| Forested Land in Commercially-Zoned Areas | 2,525.0 | 2,316.7 | 2,105.4 |
| Forested Land in Residentially-Zoned Areas | 2,017.2 | 1,834.7 | 1,631.3 |

*figure 2.03.*

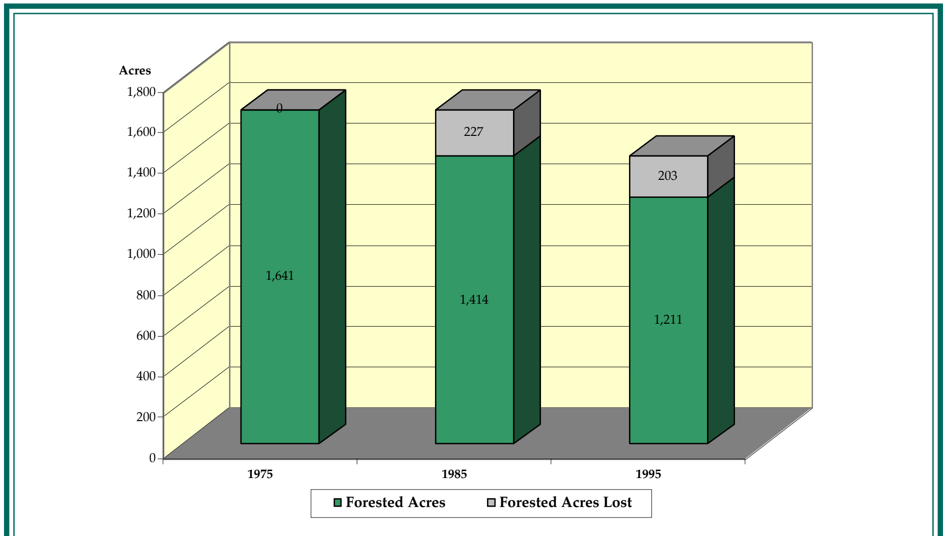



*figure 2.04. Twenty-year trend of regional forest loss on commercial land in New Jersey within the US Route 1 corridor study area. (Does not include the City of Trenton)*

Forested land cover on commercially developed and commercially zoned lands averaged a 21 acre per year loss over the twenty-year study period and residential land use averaged 28 acres of forestland lost per year.

Although the research indicated that less forested land was lost from 1985 to 1995 (508 acres) than in the ten years previous (534 acres), it was actually a higher percentage loss; there was less forested land (4,662 acres) to begin with in 1985 as compared to 5,157 acres in 1975. Thus, forest cover losses within the entire study area were more than 10% in the first ten years and more than 20% over the twenty years spanning from 1975 to 1995.

The resulting forest loss trend was projected for the study area through the year 2015, using the same rate of urban forest loss as from 1975 to 1995. If the trend in the loss of forest land cover remained the same due to development continuing at similar rates, developers not changing their courses of action and local decision-makers not strengthening their ordinances associated with planting and preserving trees on commercial sites, then by 2015 only 27% of the area would be urban forest cover – just over 3,200 acres – 1,875 acres less forest land cover than what was indicated in 1975. (figure 2.05)

The analysis also indicated that commercial properties were not entirely to blame for the loss of urban forest cover. In 1995 22% of commercial property was forested (1,211 acres), whereas 32% of residential land and 59% of undeveloped land was forested. (The undeveloped land was not 100% forested, because 41% of it was fields and agricultural land.) Using the 1995 boundaries for the three types of land uses within the study region, the historical changes in land cover were examined. By plotting the amount of forest cover for each of the three land-uses over twenty years, the trend became clear. (figure 2.06)

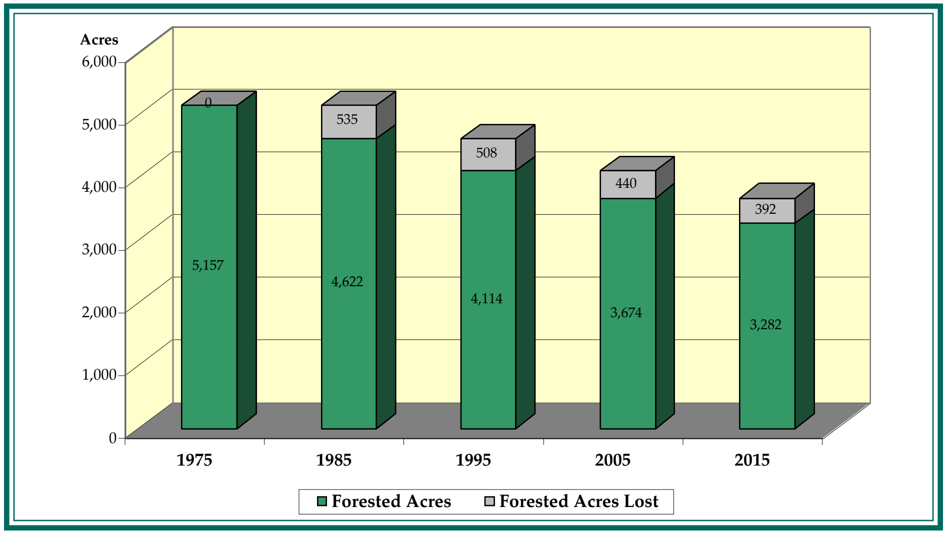



*figure 2.05. Twenty-year trend and twenty-year projection of regional loss of forest cover in New Jersey within the US Route 1 corridor study area. (Loss projected through 2015 using same rate of loss measured from 1975 to 1995. Does not include the City of Trenton.)*

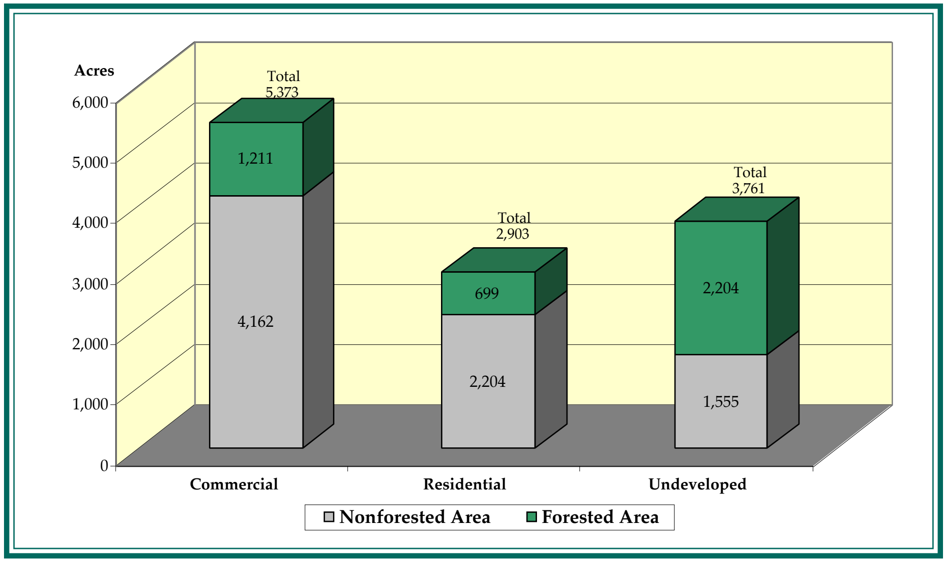



*figure 2.06. Forest cover by land use in New Jersey within the US Route 1 corridor study area for 1995. (Does not include the City of Trenton)*

The forested land cover within the parcels identified as undeveloped land use in 1995, were forested in 1975 and 1985, which indicated little change. The plotted data formed a relatively straight line, which indicated almost no loss or gain over time. The slight change was the result of manually digitizing the land cover, rather than any actual change. (figure 2.07)

Although the slopes indicating the changes in forested land for both commercial and residential land uses were practically parallel, the twenty-year analysis indicated that the percent conversion of forested land cover to non-forested land cover was slightly greater in areas that were developed residentially, rather than those developed commercially. Commercial land was not a winner, however. In 1995 23% of commercial land use was forested, whereas 31% of the same area had been forested in 1975.

Whether looking at the study area as a region or by individual municipalities, the change in land cover indicated a general trend of tree cover loss, with the exceptions of three communities in their first ten years. Entire municipalities were not studied, just their land within the study area along the US Route 1 corridor. 1985 indicated forest canopy gains in Lawrence, West Windsor and Plainsboro. At first glance, it was assumed that there was no development or perhaps a planting effort had been undertaken on old sites or on newly developed sites. Actually the gain was the result of fallow agricultural lands, some awaiting development, that changed from cropland to brush/shrub and ultimately into new-growth forest cover. Although there were gains in all three municipalities in the first ten years, the second ten years showed a loss of urban forests in all three. (figure 2.08)

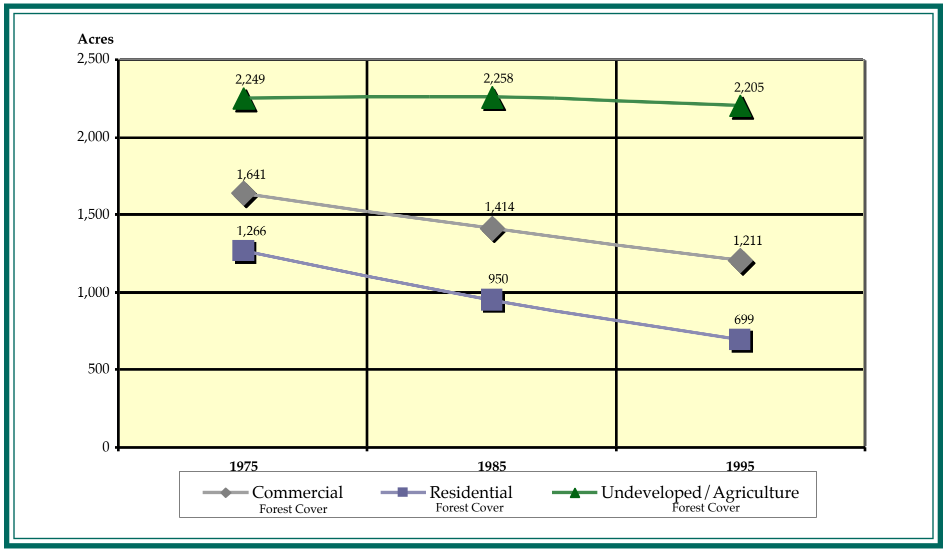



*figure 2.07. Twenty-year trend of forest cover loss by land use in New Jersey within the US Route 1 corridor study area. (Does not include the City of Trenton)*

| FOREST LAND in US ROUTE 1 CORRIDOR STUDY AREA by NEW JERSEY MUNICIPALITY | | | |
|---|---|---|---|
| **Municipality** | **1975 (in acres)** | **1985 (in acres)** | **1995 (in acres)** |
| **Lawrence** | 793.2 | 897.9 | 838.6 |
| **West Windsor** | 461.5 | 499.1 | 396.9 |
| **Plainsboro** | 110.7 | 208.4 | 177.9 |
| **South Brunswick** | 2,079.7 | 1,868.4 | 1,768.9 |
| **North Brunswick** | 1,206.3 | 846.8 | 738.5 |
| **New Brunswick** | 169.3 | 151.9 | 149.2 |

*figure 2.08.*

West Windsor had an 8% gain in forested land in the first ten years, followed by a 20% loss in the second decade for the same area. Much of West Windsor's land had been cropland with little forest cover, prior to the surge in commercial and residential development. Lawrence went from a 13% gain in ten years to a 7% loss in the next ten years; and the total tree canopy in 1995 had increased 45 acres from the original 1975 amount. This increase probably was from the slowing of development (less tree removals), as well as the growth of existing trees and forested land. Plainsboro was another community whose agricultural cropland and fields changed to commercial and residential land use. It also showed a total gain of 67 acres of forested land over twenty years. They had an 88% gain in the first ten years, followed by a 15% loss between 1985 and 1995 when more development occurred. With the noted exceptions, the findings indicated an overall loss of tree cover due to development and its current associated practices. (figure 2.09)

The scientifically measurable benefits associated with an individual tree were generally small in comparison to the expense of planting and maintenance. However when viewed on a regional scale the benefits associated with the preservation and inclusion of trees and urban forests were significant and should be considered in the development and land-use planning process.

The CITYgreen analysis indicated that urban forest land covers provided significant benefits to the region. In 1975 alone, the 5,157 acres of forest land cover in the study area removed more than 207 tons of air pollutants, which provided the region with $1,122,965 in benefits (using a 1999 monetary value). This was calculated solely on the forest cover within the study, including the commercial, residential and undeveloped areas. As forest cover decreased over twenty years, so did the economic benefits of their presence. (figure 2.10)

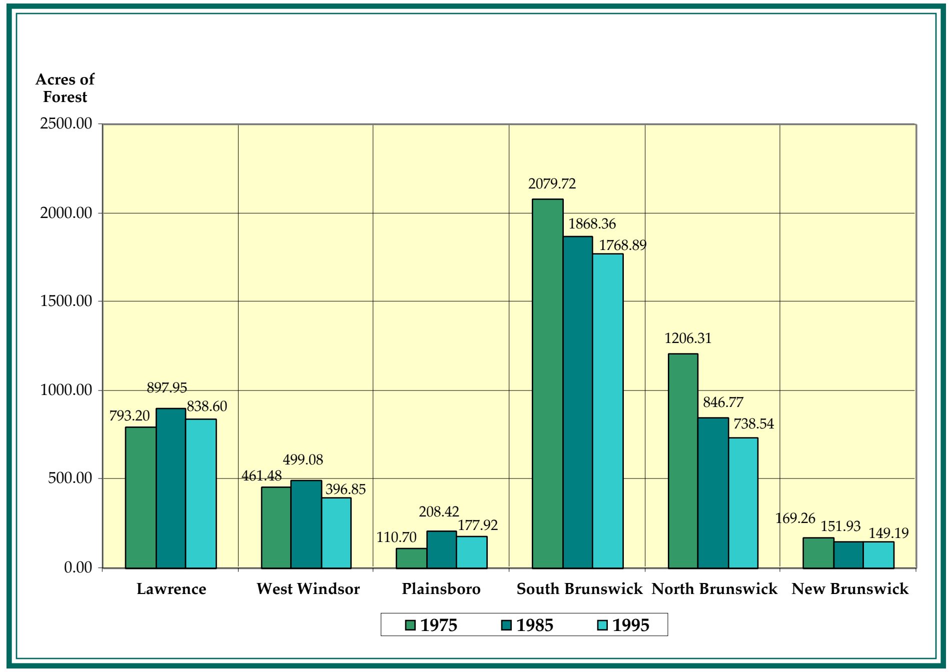



*figure 2.09. Twenty-year trend of forest cover loss by New Jersey municipality within the US Route 1 corridor study area. (Does not include the City of Trenton.)*

**Pollution Removal Benefits Provided by Forest Land Cover in Study Area**

| Year | Air Pollutants Removed in Tons per Year | | | | | Total Tons Removed | Regional Value |
|---|---|---|---|---|---|---|---|
| | Ozone | NO2 | SO2 | PM10 | CO | | |
| 1975 | 79.91 | 32.98 | 19.75 | 66.60 | 8.30 | 207.54 | $1,122,965 |
| 1985 | 71.62 | 29.56 | 17.70 | 59.69 | 7.44 | 186.01 | $1,006,463 |
| 1995 | 63.75 | 26.31 | 15.76 | 53.13 | 6.62 | 165.57 | $895,882 |
| 2005 | 56.93 | 23.50 | 14.07 | 47.45 | 5.92 | 147.87 | $800,082 |
| 2015 | 50.85 | 20.99 | 12.57 | 42.39 | 5.28 | 132.08 | $714,648 |

*figure 2.10.*

By 1995 the 166 tons of air pollutants removed by the urban forest cover within the study area provided only $895,882 of air quality benefits to the region. Although there was almost twice as much land zoned for commercial development (6,935 acres) as there was undeveloped land (3,761 acres) in 1995, the commercially-zoned land provided almost the same pollutant removal benefits to the region ($458,410 for the removal of 85 tons of pollution) as the undeveloped land use did ($479,938 for the removal of 89 tons). The zoned land was not entirely undeveloped; it included areas whose land use was commercial. If the areas zoned for commercial development were developed in a manner that would cause the loss of large amounts of forest land cover, then the ability to mitigate air pollution in the region will spiral downward. (figure 2.11)

Forest land cover within commercial areas provided $263,682 in benefits, almost 30% of the entire economic benefit to the region. Of the 166 tons of air pollutants removed by the presence of forest land cover in the region during 1995, most of the removed pollutants was particulate matter (32%) and ozone (39%). Ozone removal in 1995 provided benefits to the region at a value of $452,370. (figure 2.12)

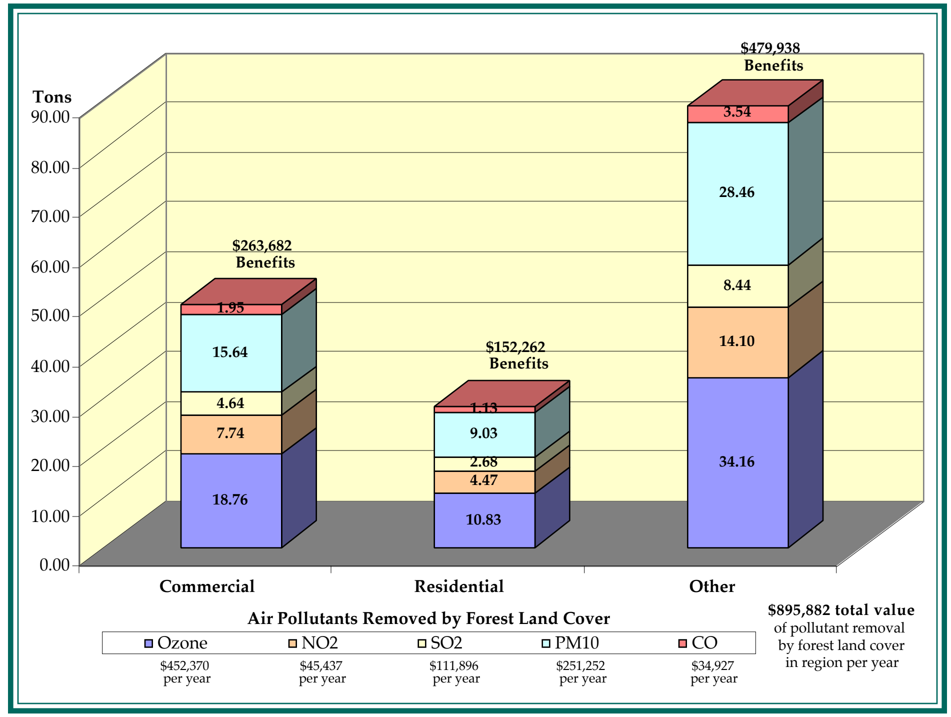



*figure 2.12. Air pollution removed by forest land cover in New Jersey within the US Route 1 corridor study area as determined by land use. (Does not include the City of Trenton.)*

| Air Pollution Removal by Urban Forests in NJ Study Area for 1995 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entire Study Area | | Commercial Areas | | Residential Areas | | Undeveloped Areas | | Commercially Zoned | |
| Pollutant | Tons/yr | Value | Tons/yr | Value | Tons/yr | Value | Tons/yr | Value | Tons/yr | Value |
| **Ozone** | 63.75 | $452,370 | 18.76 | $133,121 | 10.83 | $76,850 | 34.16 | $242,399 | 32.62 | $231,472 |
| **NO2** | 26.31 | $45,437 | 7.74 | $13,367 | 4.47 | $7,720 | 14.10 | $24,351 | 13.46 | $23,245 |
| **SO2** | 15.76 | $111,896 | 4.64 | $32,944 | 2.68 | $19,028 | 8.44 | $59,924 | 8.06 | $57,226 |
| **PM10** | 53.13 | $251,252 | 15.64 | $73,962 | 9.03 | $42,703 | 28.46 | $134,587 | 27.19 | $128,582 |
| **CO** | 6.62 | $34,927 | 1.95 | $10,288 | 1.13 | $5,962 | 3.54 | $18,677 | 3.39 | $17,886 |
| **TOTAL** | **165.57** | **$895,882** | **48.73** | **$263,682** | **28.14** | **$152,262** | **88.70** | **$479,938** | **84.72** | **$458,410** |

*figure 2.11.*

By projecting the loss of forest cover in the study area using the twenty-year historical trend, air pollution removal benefits were projected for the years 2005 and 2015. It was projected that in the year 2005, the remaining forest land cover would provide $322,883 less benefits than was provided in the year 1975. By the year 2015, the $1.1 million dollars of pollution removal benefits for removing 166 tons of air pollutants in 1975, would dwindle down to just over $700,000 for the removal of 132 tons of pollutants. (figure 2.13)

Traffic would probably have increased in the area due to increased residential and commercial development, which would have caused an increase in the amount of pollution from the traffic. Pollution would increase at the same time that the natural pollution removers – urban forests – would be reduced, which would negatively affect the quality of life for the residents in the study area and the surrounding region.

In addition to removing air pollutants, the trees in the region's urban forest acted as a storage unit for carbon, which helped reduce the greenhouse effect. The trees sequestered approximately 1,728 tons in 1975, bringing the total amount stored by the urban forests to 221,895 tons. By 1995 the remaining trees stored only 177,009 tons of carbon at a lesser rate of 1,378 tons per year. Projections indicated that by the year 2015 the existing forests stored just over 141,000 tons at a rate of 1,100 tons per year – a 36% reduction in forty years. (figure 2.14)

The analysis also highlighted the crucial role that urban forest land covers played in the management of stormwater. As the distribution of land cover shifted from natural pervious cover to impervious (buildings, parking lots, road, etc.) through development, so the degree of runoff increased in direct proportion. The stormwater runoff results were the measurement of the amount of rainfall that was not naturally absorbed into the ground and thus ultimately flowed into surface water bodies or stormwater drains.

The effects of forest land cover in mitigating stormwater runoff proved considerable in the regional analysis. Based on the 1995 land cover distribution within the study area, a storm event of 3.5 inches of rainfall in 24 hours led to 1.37 inches of runoff – more than 447-million gallons of runoff. Using the land-cover distribution for the region twenty years earlier, the results from a similar analysis indicated only 1.18 inches (385-million gallons) of runoff, which was 62-million gallons less than the stormwater runoff in 1995. (figure 2.15)

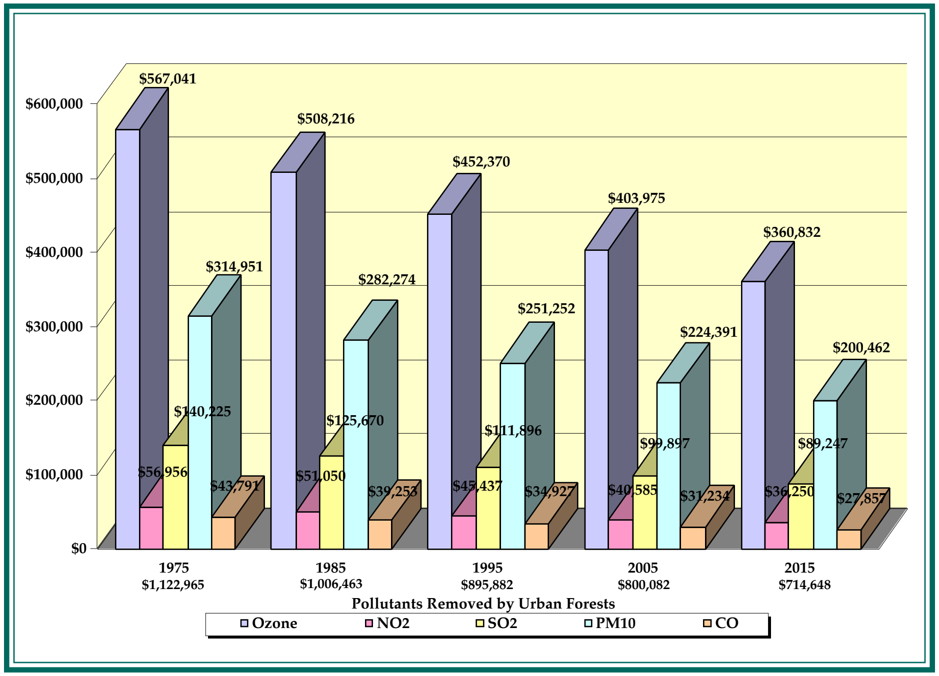



*figure 2.13. Quantified and projected value for pollution removal by forests within the US Route 1 corridor study area from 1975 to 2015. (Does not include the City of Trenton.)*

**Carbon Storage Benefits Provided by Forest Land Cover in Study Area**

| Year | Carbon Storage (tons) | Carbon Sequestration (tons/yr) |
|---|---|---|
| 1975 | 221,895 | 1,728 |
| 1985 | 198,908 | 1,549 |
| 1995 | 177,009 | 1,378 |
| 2005 | 158,112 | 1,231 |
| 2015 | 141,234 | 1,100 |

*figure 2.14.*

**Stormwater Benefits Provided by Forest Land Cover in Study Area**

| Year | Stormwater Runoff (inches) | Stormwater Runoff Volume (cubic feet) | Stormwater Runoff Volume (gallon) |
|---|---|---|---|
| 1975 | 1.180 | 51,559,286 | 385,199,424 |
| 1985 | 1.302 | 56,889,992 | 425,025,127 |
| 1995 | 1.370 | 59,861,205 | 447,223,060 |
| 2005 | 1.506 | 65,803,631 | 491,618,926 |
| 2015 | 1.597 | 69,779,813 | 521,324,983 |

*figure 2.15.*

Stormwater runoff was highest within commercial land use areas. Although commercial land use was identified for 45% of the study area in 1995, it resulted in 1.71 inches of runoff (249-million gallons) for a 3.5-inch storm event, which was 56% of the entire region's runoff volume. (figure 2.16)

| Additional Benefits Provided in 1995 by Urban Forests in NJ Study Area | | | | | |
|---|---|---|---|---|---|
| | Entire Study Area | Commercial Land Use Areas | Residential Land Use Areas | Undeveloped Land Use Areas | Commercially Zoned Land Use Areas |
| Carbon Storage (tons) | 177,009 | 52,088 | 30,063 | 94,858 | 90,603 |
| Carbon Sequestration (tons/yr) | 1,378 | 406 | 234 | 738 | 705 |
| Stormwater Runoff Volume (inches) | 1.37 | 1.71 | 1.57 | | 1.50 |

*figure 2.16*

The change in land cover from undeveloped to developed within the study area resulted in increased stormwater runoff for each storm event. By the year 2015 the amount of stormwater runoff from a 3.5-inch storm event in the area totaled more than 521-million gallons, if forest loss continued at the same rate. This created a runoff increase of 136-million gallons as compared to the same storm event in the same area in 1975.

The negative effects of stormwater runoff on surface water and groundwater quality were significant. An increase in stormwater runoff was responsible for several deleterious effects. Rainfall was vital to the recharge of underlying aquifers, a process that relied on pervious cover to allow assimilation into the landscape. Stormwater runoff was also responsible for carrying sediment and excess nutrient loads into surface water bodies, resulting in a degradation of water quality and impairing beneficial use of streams, rivers, lakes and ponds in the watershed. Additionally, as pervious surfaces and forested lands decreased, the potential for flooding increased.

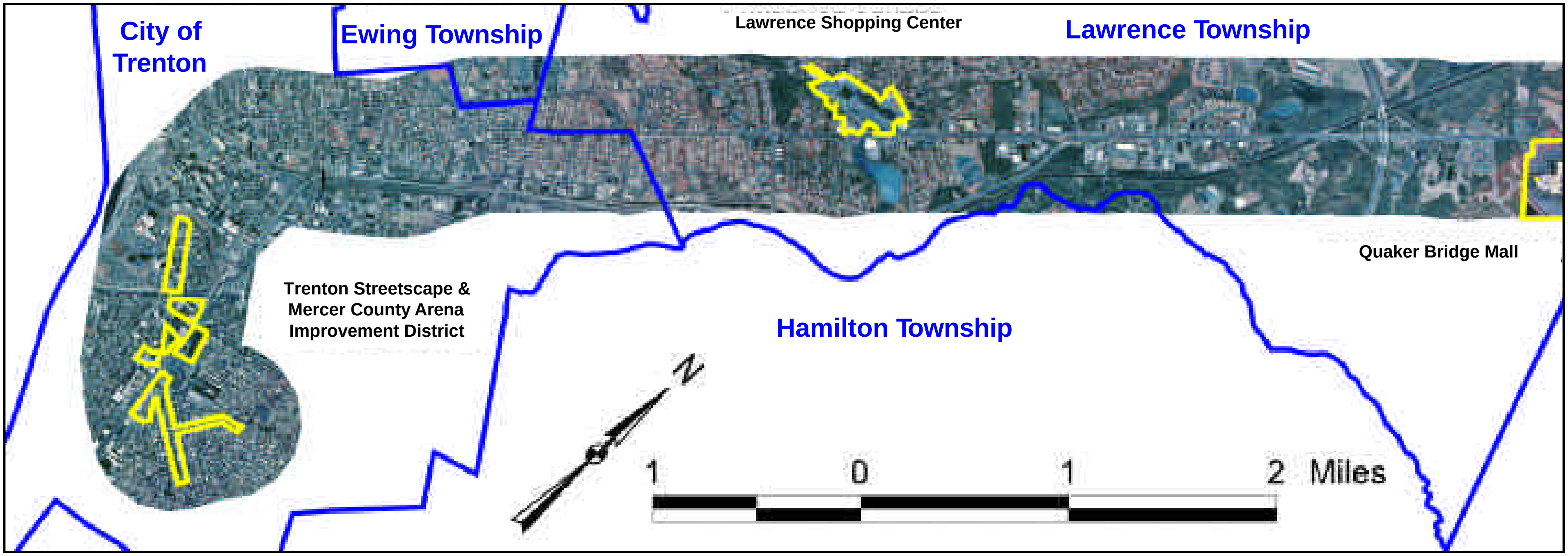
The energy conservation benefits provided by the trees in the study area were not measured, because the CITYgreen software provided estimates only when trees were within 35 feet of one or two-story buildings. This measurement was unsuitable at most of the sites within the study area. There were no other models available that could provide a realistic value for the energy savings provided by the forested land in the region.

Increased pervious surfaces and increased activities by people that generate heat (such as driving gas-powered vehicles) caused urban heat islands with increased ambient air temperatures. Vegetation in parking lots, as well as those planted near paved areas or buildings, reduced the effects of urban heat islands by shading surfaces (which reduced the build-up of heat radiated from the surfaces) and dissipating the heat through evapo-transpiration and through the directing of the wind currents. Studies were underway to provide modeling techniques for the energy savings and pollutant reduction/removal provided by trees in parking areas that cool pavement, shade buildings, reduce temperatures inside parked vehicles and decrease the heating of gas tanks, which emit gas fumes when heated. Although there was no way to estimate or quantify the value of urban heat island reduction effects in the region, these benefits were recognized to occur within the study area.

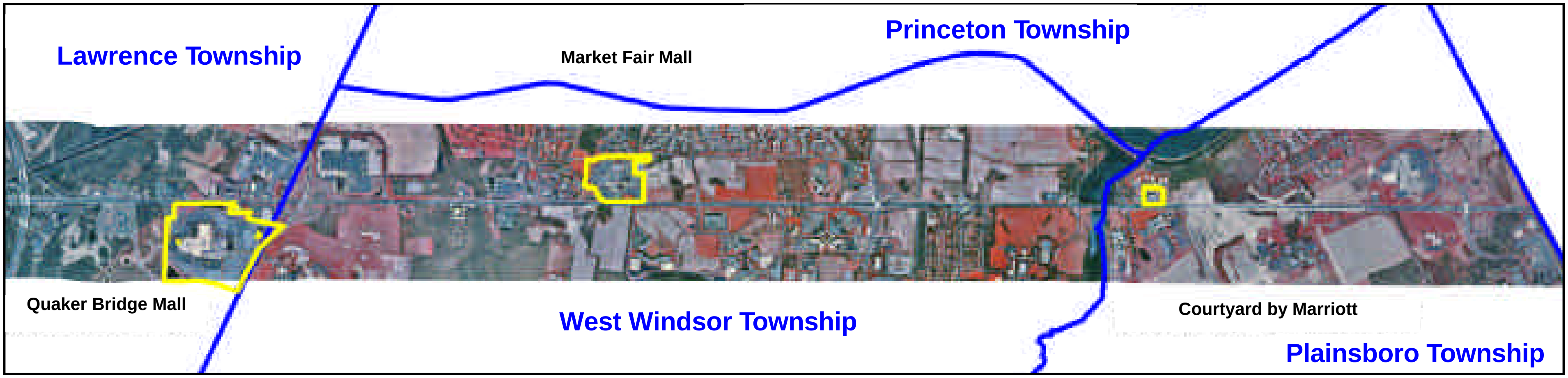
## Regional Trends Conclusions

In the New Jersey study area the regional trend analysis was successful in identifying the loss of forest canopy in commercially developing areas. It also demonstrated a connection between the loss of forestland on commercially zoned properties and decreased air quality and increased stormwater runoff. On a regional scale the benefits associated with the preservation and inclusion of trees and forests were significant.

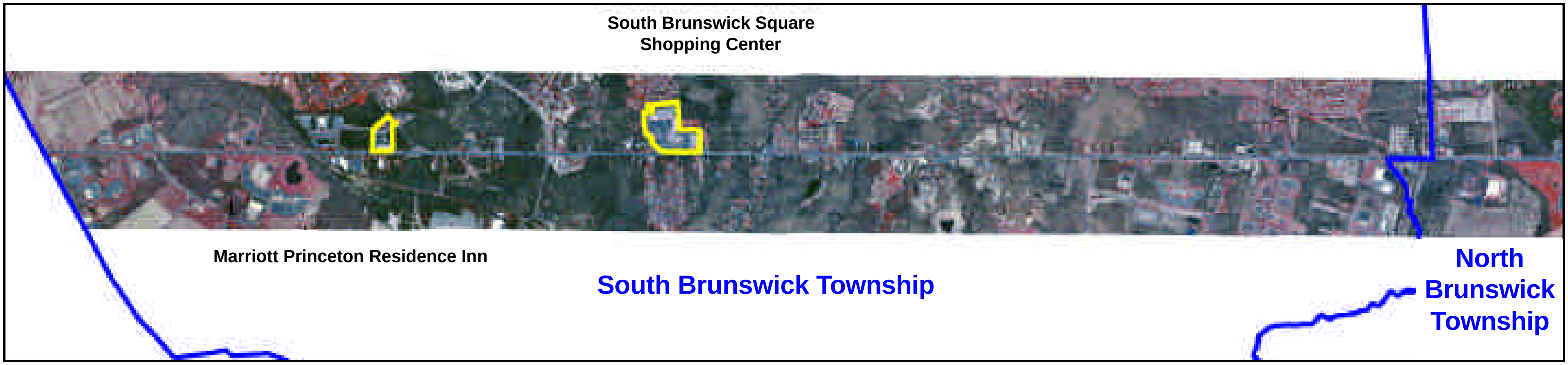
The benefits of urban forests in the region were undermined, as 21% of the forested land cover in the study area was lost for the sake of development over twenty years. And 26% of the forested land on commercial land use parcels was lost in the same time period. The analysis indicated that forest land cover in the study area provided significant air quality benefits to the region (nearly $900,000 of air-quality benefits in 1995) and played a crucial role in the management of the region's stormwater. As the trees disappeared, so did the economic benefits that they provided to the region as natural pollutant removers, stormwater run-off reducers and carbon storage mechanisms.



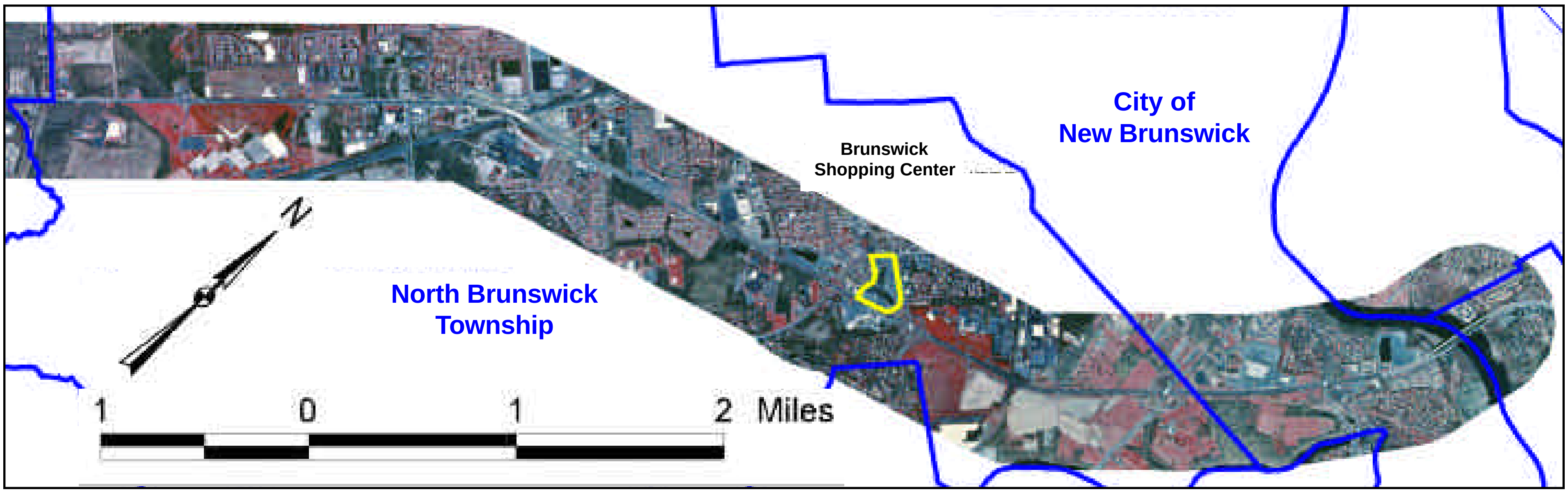

*Map 2.01a: Part 1 - Satellite Imagery of USRoute 1 Corridor Study Area in New Jersey with Part Four Case Studies outlined in yellow.*




*Map 2.01 b: Part 2 - Satellite Imagery of USRoute 1 Corridor Study Area in New Jersey.*




*Map 2.01 c: Part 3 - Satellite Imagery of USRoute 1 Corridor Study Area in New Jersey.*




*Map 2.01 d: Part 4 - Satellite Imagery of USRoute 1 Corridor Study Area in New Jersey.*

# IMAGE BASED VALUATION SURVEY

## Image-Based Valuation Survey Summary

The photographic image-based valuation survey (IBVS) estimated the economic value of trees and landscaping at retail shopping centers as perceived by the consumers or users of the retail sites. The project survey instrument combined two popular evaluative models from two different disciplines – economics and urban planning. The contingent valuation approach was a widely practiced and highly scrutinized method to measure the willingness to pay (WTP) of a survey respondent – particularly for public goods. The image-based or visual preference approach was a popular, but relatively unscientific method used to elicit the preferences of a survey respondent to features depicted in photographic images. The project's IBVS method required respondents to observe images and express a willingness to pay for their preferred shopping settings, in this case by increasing their travel time.

The image-based valuation survey was able to demonstrate the following:

- Customers did prefer green elements within commercial shopping areas.
- Customers were more likely to choose a greener shopping center, mall or downtown shopping district over one with less green elements.
- Customers were willing to pay for this preferred level of green in a shopping area by travelling further to shop there.

## Image-Based Valuation Survey Hypotheses

The primary objective of this component of the project, the photographic image-based valuation survey (IBVS) was straightforward – to estimate the economic value that consumers place on trees in retail shopping areas. In other words, would shoppers be willing to pay more to shop at greener shopping centers or districts (i.e. with lots of trees)? While the goal seemed straightforward, the task was complex. Namely, to find out whether or not consumers placed any value at all on shopping center amenities and, if they did, to devise a mechanism by which they could express that value in economic terms.

It was hypothesized that if consumers in fact value green, it might be a very subtle preference, perhaps below the level of immediate consciousness. It would then be inappropriate to compare the importance of trees in one's shopping experience to the brand names of items or the prices of certain goods at that shopping center. The variable of interest (trees) had to be set in the appropriate context with other amenities in the same domain, so that the dependent variable was a salient issue in the mind of the respondent.

A hypothetical method of payment to have greener shopping centers, such as parking fees/taxes, increased prices of goods inside the stores, or entry fees would have been so unfamiliar or remote that respondents might have had trouble specifying their willingness to pay. Indeed, this was one of the primary criticisms of contingent valuation approaches for public goods. The payment mechanism had to be tangible, immediate and somewhat relevant to a respondent's decision of where to shop.

If trees/landscapes were considered an amenity at retail shopping areas, they were likely to provide public benefits and add consumer value in several subtle ways. Three distinguishable values were:

- *Visual Benefit* - Autumn leaves, holiday lights, spring blossoms and summer greenery provided public benefits that increased the attractiveness of shopping facilities' exterior setting for the customers, the nearby residents and those traveling by the site.
- *Shading Function* - During hot/sunny weather, shade trees at shopping centers reduced ambient air temperatures in parking lots and surrounding areas by sheltering vehicles, buildings, pedestrians and paving.
- *Signaling Value* - A higher quality and amount of landscaping appeared to be associated with high-end specialty shops. If it was true, then landscaping provided a benefit to both the retailer and consumer. Landscaping served as advertising, helping the shopper decide if the associated shops will cater to their needs.

## Image-Based Valuation Survey Objectives

The objectives of this part of the study were:

- To estimate the relative importance of trees/exterior landscaping as shopping center amenities to the consumer;
- To determine consumers' preferences to shop at greener shopping areas based on photographic images; and
- To quantify consumers' hypothetical willingness to pay to shop at greener shopping areas.

## Image-Based Valuation Survey Methodology Background

### Contingent Valuation Description

Although the contingent valuation (CV) method has become widely used to place values on public goods, it was also heavily criticized as shown in the following statements:

- "Intrinsic values are by definition non-tradable and therefore not economic." To the extent that trees have a value by their mere existence, this value cannot be traded—it is either present or absent. Duke University Professor V. Kerry Smith compiled 32 previously published papers and found that, although people's choices considered intrinsic values, there remained difficulties in constructing economic values of the services of nature. Despite these difficulties, other studies demonstrated that people have a willingness to pay for the preservation of (for example) the Grand Canyon, even if they never anticipate visiting it during their lifetime.

- "People have different budget constraints, which greatly influences their willingness to pay." For example, a $50 entry fee may be inconsequential to a wealthy person but a significant barrier to enjoyment to a poor person. Gregory (1995) found that "hypothetical willingness to pay was found to be highly dependent on the size of the budgetary unit."

- "Hypothetical payment mechanisms are simply not accurate due to their hypothetical nature." In fact, because the payment was hypothetical, the respondents typically greatly overstated their willingness to pay because they did not believe that the payment would actually be extracted. "The results of these valuation practices will, therefore, bias environmental policies and distort incentives." (Knetsch, 1994)

- "There is a huge difference between preservation of Yellowstone and a few street trees." Smith (1996) found during a telephone survey that people recognized this and were able to discriminate between significant and trivial causes, in this case, between two highway environmental programs (recycled rubber pavement and wildflower plantings).

The introduction to Kerry's (1996) study proposed three characteristics as especially important to more acceptable contingent valuation (CV) estimates of economic values:

- CV choices should be responsive to the scope or amount of the commodity offered to respondents.

- CV choices should pass construct validity tests in that they are related to a set of economic variables hypothesized to be important in observed choices, including price, budget constraint, quality, available substitutes and tastes.

- CV choices involving objects, that can generally be argued to be different, should be significantly different.

Kahneman and Ritov (1994) similarly argued that "designers of future contingent valuation surveys should accept the burden of showing that their procedures are adequately sensitive to the scope of problems and of interventions, that they avoid embedding effects and that they are robust to preference reversals… Perhaps most important, it appears essential to demonstrate that contingent valuation properly discriminates significant causes from trivial ones."

### Visual Preference or Image-Based Survey Description

The literature was quite sparse regarding visual preference techniques, but a local consultant and Rutgers University planning professor, Antoine Nelessen, developed a method that he has tested throughout the country and internationally. For this element of the study, he was consulted personally and materials from his firm were used to generate the image-based portion of the pretest and final survey.

Nelessen's visual preference survey methodology gathered community officials and citizens, then showed them slides of up to 240 photographic images and digitally modified images of various development patterns, land uses, building types and streetscapes. The photos shown may include scenes from the local community (existing conditions), modified scenes of the local community (proposed conditions) and/or alternatives outside the local community. Shown in a group setting, the respondents were given a numbered rating sheet corresponding to the images projected on the screen. As the images were shown the respondents ranked each slide on a scale from +10 (positive) to –10 (negative). "Participants are instructed to rate images they find desirable and appropriate for the site under consideration with positive scores and those they find undesirable, with negative scores." Using the results, Nelessen's staff proposed urban design changes for local communities, which were consistent with the preferences of the group.

Only one scholarly article was found regarding the use of image-based testing as a means of revealing environmental preferences. Interestingly, the study (Hanley and Ruffell, 1993) also attempted to measure contingent valuation with a visual preference technique. The investigators showed pairs of photographs depicting various forest features to weekend visitors at a forested park and gave each respondent a payment card that included a range of discrete monetary values to which the respondent could mark as the maximum willingness to pay for the preferred attributes. The interview went as follows: participants were shown a pair of images that differed in only one characteristic and the interviewer asked them which forest they found more attractive.

Respondents were then asked to imagine that this preferred forest was more expensive to visit than the other forest. Then they were asked how much extra would they be willing to pay to visit the forest they liked the best rather than the other. While Hanley and Ruffell found differences in WTPbetween certain images, there was significant variation with respect to other features in the image (i.e. presence of a water feature, percentage of image depicting sky and mixture of tree species) and a total of 71 protest bids (i.e. refusal to answer the question on philosophical grounds) out of 859 observations.

## Gravity Model of Retail Marketing Description

Between the 1930's and the mid-1980's, most retail market location decisions were governed by what has been termed "Reilly's Law of Retail Gravitation". In its simplest form, the gravity model merely applied laws of physics to retail market patterns. Rather than presuming that spatial location was absolute, the model proposed that location and thus retail shopping behaviors were relative. Consumers and retail centers were treated as celestial bodies, which were attracted by their respective sizes and the distances between them. This was represented by the equation, G=M/d2, where G was the gravitational attraction, M was the mass or size and d was the distance between the two points of interest. Substituting retail markets, the attractiveness of a shopping center was a function of its size divided by the square of its distance from its market population. Just as "100 miles from the earth" was not the same as "100 miles from the sun," so too was "20 miles outside of New York City" not the same as "20 miles outside Topeka."

Using only the square footage of retail space available at a facility as the measure of attraction (G), and only the population size (M) of surrounding areas, the market area can be calculated by solving for the distance variable. This basic model, despite its simplicity, has proven to be remarkably accurate empirically to define where the market boundaries were for a given retail center, existing or proposed. Those boundaries were entirely deterministic (i.e. if a consumer lived within a market boundaries, she/he will do 100% of shopping there). Instead, Huff (1962) asserted that Reilly's model could be used probabilistically (i.e. the closer the population was to a retail center, the greater the pull that center had on that population). In other words, there was a dynamic between competing retail centers and their market areas. Increasing the attractiveness and/or decreasing the distance increased the probability of a population selecting that center over another.

This basic model was modified and adapted in order to account for specialized retail goods and/or particular populations. Haynes & Fotheringhamm (1985) and Krueckeberg & Silvers (1974) provided an excellent review of these modifications.

Most relevant for the purposes of this part of the study were modifications that decomposed the attractiveness measure into many more features than simply square footage of space. For example, the name brands offered at that store, its proximity to major highway exits and even friendliness of staff might be considered attributes of the attractiveness of a shopping center. As probabilistic tools, such models became more like multiple regression models than pure gravity models as proposed by Reilly in 1929, but were useful nevertheless.

### Image-Based Valuation Survey Methodology

For this part of the project study, the photographic image-based valuation survey was selected as the methodology to be used to estimate the economic value of trees and landscaping at retail shopping centers as perceived by the consumers or users of the retail site. It incorporated both the contingent valuation (CV) and the visual preference/image-based valuation survey (IBVS) models. This format was selected not only for the novelty of blending the two distinct methods, but also to use visual images in an attempt to import relevance and context to the hypothetical valuation questions.

## Image-Based Valuation Survey Pretest Development and Design

It was determined that an IBVS pretest would help researchers design the survey techniques. The objectives of the pretest were 1) to find an appropriate design to use, 2) to determine whether the question order and wording of the instrument were appropriate, 3) to test the ability of respondents to express preferences based on photographic images, and 4) to test the ability of respondents to express those preferences in terms of a hypothetical willingness to pay.

Timothy J. Chandler, the project consultant for the IBVS element of the project and Jan Bisco Werner, TNJ Executive Director developed the IBVS pretest. Professor Herb Abelson of Princeton University provided significant support and advice. Valuable input to the design and development of this section of the project was also provided by Professor A. Haughwout of Princeton University Woodrow Wilson School, Professor Toni Nelessen of Rutgers University, the staff of A. Nelessen & Associates and the professionals on the Project Advisory Committee (listed in the *Preface*), who reviewed and commented on the IBVS methodology.

In terms of the questionnaire design, information thought to be relevant based on the literature review was demographic information such as income, education and travel behavior, preferences for shopping center amenities and a series of images that could be evaluated by respondents. For the images, questions addressed both a visual preference and a willingness to pay. Four types of survey formats were considered.

- *Slides* – Like Nelessen's approach, participants would be gathered in a room with two slide projectors showing images and would respond on a preprinted response form. This approach had the advantages of recruiting large numbers of participants at a time, minimizing the time necessary for investigator to conduct multiple surveys and improving the consistency of survey administration (i.e. highly controlled setting, only one person giving instructors, etc.) On the other hand, it was difficult to show slides at a speed that was acceptable to all, and participants may be distracted and/or uncomfortable in a dark room with strangers.

- *Prints in a Notebook* – Participants would proceed on their own through a prepared notebook with groups of images to be compared on separate pages, then record responses on a preprinted form. This format would allow respondents to go at their own speed and receive assistance if needed, but may be an intimidating setting to attract volunteers.

- *Mural Display* – Images would be arranged individually and/or in pairs along a wall. Participants would be given a preprinted form for their responses at the entrance of the display and then return the completed form at the exit. This format had the advantage of processing large numbers of people relatively efficiently, but posed problems in terms of outside distractions and circulation. It would also be difficult to take this type of display on the road to various sites.

- *Oral Interviews* – Trained interviewers would individually survey the participants by showing images and asking questions. This approach would likely yield the most information, because detailed responses and comments could be recorded. The costs of conducting such a survey to obtain a large number of observations would be prohibitive.

In determining where to administer the IBVS, shopping centers were initially considered as an appropriate locations to ask questions about retail shopping preferences as they often had high volumes of traffic from which to draw participants. However it was often difficult to get permission from mall management to conduct a survey on-site, because many only allowed their own market researchers to perform on-site interviews. Also some shoppers may be uncomfortable or offended when interrupted from their shopping experience. Additionally the selected shopping center may introduce a sample bias towards its own type (i.e. the fact that people are shopping at, say, a super regional mall with no landscaping may be correlated with an underlying preference for super regional malls and/or for no landscaping). Upon the advice of Professor Abelson, the alternative of using local groups as sample pools was also a viable alternative. The obvious advantage was cost savings and ease of access to moderate-sized groups of participants; the chief disadvantage, however, was the potential for associated groups to have similar preferences and thereby the true preferences of the population would be masked by a non-representative sample.

## Image-Based Valuation Survey Pretest Implementation

A pretest was administered in December 1998 at Princeton Market Fair shopping center in West Windsor, NJ. One person conducted a total of 12 interviews on two days with each interview lasting from 10 to 14 minutes. The objectives of the pretest were to find an appropriate design for the survey, to determine whether the question order and wording of the instrument were appropriate, to test the ability of respondents to express preferences based on photographic images and to test the ability of respondents to express those preferences in terms of a hypothetical willingness to pay.

The interviewer approached people in the mall who appeared to be waiting or resting on benches or at tables in the common area of the food court. They were asked if they would be willing to spend approximately 11 minutes answering questions regarding their preferences for shopping centers. At the end of the interview, all participants received a $10 gift certificate valid anywhere in the mall, along with a TNJ bookmark and a packet of tree seeds.

The pretest questions were organized in five distinct categories: 1) demographics, 2) travel behavior, 3) amenity preferences, 4) single-image decision making, and 5) multiple-image decision making.

## Image-Based Valuation Survey Pretest Findings and Recommendations

Although the sample was very small and not necessarily representative of the shopping population, the IBVS pretest was successful in meeting its objectives and providing information to determine modifications for the final IBVS. The pretest suggested that by using only photographic images as a context consumers were able to express their preferences based on hypothetical situations and were able to state their preferences of a hypothetical willingness to pay.

Additionally the pretest helped develop an appropriate survey format, including question order and wording. The responses and the follow-up questions in the IBVS pretest helped determine which questions contained words that caused confusion, which questions could be deleted and which image formats/sequences were easier for comparison and allowed people to state their preferences.

The following modifications were recommended as a result of the pretest: Brand names in the photographs needed to be removed because of the bias they caused. The single-image portion of the pretest should be replaced with a series of groups, because people were able to state their preferences easier when they compared images in a series or group, rather than evaluating a single image.

Finally the IBVS pretest showed that such a survey could be implemented in a shopping center setting, but it did not preclude the use of other locations or forums for future administrations of the survey.

## Image-Based Valuation Survey Design and Development

Based on T.J. Chandler's recommendations in his IBVS pretest report, J. Bisco Werner developed the final IBVS. Professionals, including Margaret O'Gorman, Jason Nuckols, and Barbara Eber-Schmid reviewed the final IBVS method.

The first page of the final IBV survey requested demographic information, shopping and travel behavior, and retail shopping area amenity preferences. The final two pages contained 18 questions pertaining to images that were displayed as slides. A copy of the IBVS questionnaire was attached as *Appendix A*, along with the survey script and the corresponding photographic images as *Appendix B*.

Photographic images of retail commercial areas were selected from the files of Nelessen & Associates, with some having been digitally modified by their staff. Other images were scanned and digitally altered using Adobe PhotoShop to remove product brand and store names, to add trees, cars, or people, to flip the orientation of images, or to add curbing and planting islands. None of the images selected were of local retail sites, so as not to bias any respondents because of their familiarity with any of the sites.

Images were sorted into four categories: downtown shopping areas, suburban strip shopping centers, shopping malls and parking lots. The amount of landscaping in the photograph was calculated by a visual check and then by measuring the landscaped areas and estimating the greenness percentage, based on the amount of vegetation in each photograph. Some of the slides had trees, but were photographed without leaves. These images were digitally modified to become trees in-leaf before the greenness of the image was determined. The images were then ranked from low to high as related to the greenness percentages of the photograph. A series of images with low to high green percentages were selected for each category. The images were paired or grouped in fours for visual comparisons. Images were used more than once within a category to be able to compare how they rated against other images in that category. Some with similar amounts of green were grouped together to compare WTP preferences when comparing sites with similar amounts of greenness. The digital EPS files of the selected images were then made into slides.

## Image-Based Valuation Survey Implementation

The IBVS was administered at five sites: a local art gallery in New Jersey, a New Jersey community college, the New Jersey Department of Environmental Protection (NJ DEP) conference room as a lunchtime brown bag presentation, the Trees New Jersey office and the Trees New York office. More New Jersey sites were selected, because the images focused on a more suburban shopping experience. Professionals from the advisory committee suggested that it would be too difficult for people in New York to select urban districts solely on images with a willingness to travel, because many other considerations are involved. One being that many New Yorkers walked to shopping areas from their homes or workplaces, so their decision as to where to they shop was based more upon proximity or familiarity with the shopkeeper.

The IBV surveys were administered on a Saturday morning, a weekday evening and three times during a weekday lunch hour. Fifty-four (54) people completed the survey. People were invited to attend through fliers that were posted in public and private places. Free lunches (sandwiches, drinks and other snacks) or refreshments (desserts and drinks) were offered to the participants at all sites as a way to entice people to attend, except at the NJ DEP. The NJ DEPfliers indicated that TNJ and Cedar Lake Environmental would make a lunchtime presentation. At all other sites, the organization administering the survey was not identified until the participants completed the survey.

The final survey methodology brought together diverse groups of people. The first part of the survey gathered demographic information about the participants, as well as their travel behavior relative to shopping and their preferences of site amenities in shopping areas.

The second part of the survey was the IBVS. Slides were shown in a group setting and the respondents were given a pre-printed questionnaire to indicate their preferences of places to shop and willingness to pay (WTP) by traveling to a further place to shop. They assumed that they could purchase the same items at the same price at any of the sites being compared, so that the visual image would be what they would evaluate to make their preference, not the price of goods or type of goods available. Without that assumption the images may have prejudiced them to think a store in one image would have items that were cheaper or more expensive than what they wanted to pay or that it carried or did not carry a specific name brand.

The survey participants compared 22 slides with photographic images that had been sorted into series of multiple images for three types of shopping areas – downtown shopping areas, suburban strip shopping centers and shopping malls. The interviewer used the same script and kept the slides in the same order for all presentations. Two slide projectors were used allowing two images to be compared simultaneously when viewing pairs and four images when comparing groups. Each slide in the group comparison has two images per slide.

Within each pair of slides in the IBVS, the slide with the highest percentage of vegetation on-site was rated as the greener site of the two slides. In the groups of four or more slides, a greenness factor was established for each slide from the highest amount of green on-site to the lowest. Additionally, some of the slides being compared in pairs and groups were considered to be equal in their level of on-site greenness. The first section of the survey (Questions Nos. 1 to 13) were broken down into three series. The survey respondents were asked to indicate their site preference from a pair of choices, one having a higher level of greening than the other. They were also asked to indicate their WTP by traveling a further distance to shop at their preferred site.

The second section (Questions Nos. 14 to 16) compared images with varying levels of greenness that were grouped in sets of four. Participants were asked to select their most and least preferred sites, as well as their WTP to travel to their preferred site.

And finally in the third section (Questions Nos. 17 to 18) participants reviewed a series of parking lots, to indicate their design preferences and WTP. Additionally the survey determined if the respondents' answers would identify a pattern in linking different level of green parking lots with specific types of commercial businesses.

The results of the information about the participants, as well as their preferences of sites and willingness to pay by traveling further were then tabulated and analyzed.

## Image-Based Valuation Survey Findings

Although the sampling for the pretest and the final survey were small (12 and 54 respectively) and not necessarily representative of the total shopping population, the Image-Based Valuation Survey (IBVS) was successful in meeting its stated objectives:

- to determine the relative importance of trees and exterior landscaping among other shopping center amenities (the majority of the respondents selected exterior landscaping as one of the amenities that they preferred to have where they shopped);
- to identify consumers' preferences for shopping at shopping areas of various levels of greenness based on their evaluation of photographic images (the majority of people selected the greener sites as their preferred place to shop); and
- to estimate the economic value that consumers place on trees and landscaping at retail shopping areas by measuring consumers' hypothetical willingness to pay more to shop at greener shopping areas (people were willing to travel further, thus pay more, to shop at greener shopping areas when brands, merchandise and cost of goods were the same).

## Part A: Respondent Background Information Analysis

*Part A* of the survey gathered demographic information from the participants, as well as their travel behavior relative to shopping and their preferences of site amenities at commercial locations. Diverse groups of people participated in the IBVS, representing locations in 19 zip codes total with 14 from New Jersey and 15 from New York. Of the fifteen New York locales represented, 14 were from New York City boroughs. 69% of the survey respondents had college degrees and 65% of them were employed full-time. The gross annual household income of 46% of the respondents was from $40,000 to $90,000 with another 28% having incomes greater than $90,000.

The travel behavior of the respondents was analyzed by asking the number of visits they made to grocery stores or shopping malls within a specific time frame. Additionally they were asked the length of time they traveled to go to grocery stores and shopping malls. When traveling to grocery stores, 52% spent 5 minutes or less in travel time, with another 43% spending 5 to 15 minutes in travel time. Visiting the grocery store once a week was the most common response in a range of 0.25 to 7 trips per week with an average of twice per week.

Of the same group of people 9% said they did not shop at malls. Half of them spent 15 to 30 minutes traveling to malls to shop, with an additional 15% travelling more than 30 minutes. The most common number of trips made to the mall in a month was one trip per month in a range of responses from 0 to 15. The average was 2.5 trips to shopping malls per month.

When the participants were asked about their preferences for amenities in commercial areas, green features such as interior plants, exterior landscaping and shaded parking were weighed against non-green features. First they stated whether or not they cared if a list of special features were present where they shopped. The feature most often selected by the participants to be present where they shopped was skylights/natural lighting (87%). This feature was closely followed by the selection of exterior landscaping (85%) and interior landscaping (80%). Approximately 75% of the respondents preferred the presence of interesting architecture and shaded parking areas. And 70% preferred to find artwork/sculptures. Holiday lights/decorations and special events were the two preferred the least by the respondents. Although not selected as the number one item, the second and third choices indicate a positive preference for green elements (landscaping) inside and outside of shopping areas.

From the same list of eight features people were asked to select the top two amenities they prefer to find where they shop. The five most common responses were: Exterior Landscaping (43%), Interesting Architecture (37%), Interior Landscaping (28%), Skylights/Natural Lighting (26%) and Shaded Parking Areas (22%).

When asked to select only two of the eight features, more people selected a green landscaped exterior as one of their choices then any of the other choices. This indicates once again a positive preference for green shopping areas. When people were asked to select the two amenities they least prefer to have where they shop from the same list, the two most common responses were Special Events (69%) and Holiday Lights/ Decorations (37%). Only 1 person (2%) selected exterior landscaping to be the least preferred feature to find at a shopping area, but surprisingly enough 26% were not interested in finding shaded parking areas, which to some extent can be considered part of the exterior landscape.

## Part B: Image-Based Valuation Survey Analysis

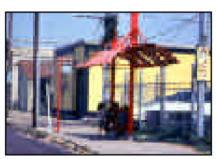
In the IBVS the participants viewed 22 slides of photographic images of retail sites sorted into various groupings – downtown shopping areas, suburban strip shopping centers and shopping malls. The slides were shown in a group setting and the respondents were given a pre-printed questionnaire to indicate their preferences of places to shop and WTPby traveling to a further place to shop.

A greenness factor was established that compared the amounts of greening (landscaping/vegetation) on-site for all pairs and groups of slides to rate them for analysis purposes from most green to least green. Some of the slides being compared were considered to be equal in the amount of greenness on site. The results of the participants' site preferences and their willingness to pay by traveling further to shop at their preferred site were then tabulated and analyzed. A "no response" to the WTP portion of the question was considered to be someone not willing to travel to shop at a preferred site.A spreadsheet summarizing the response data for the IBVS is attached as *Appendix C.*

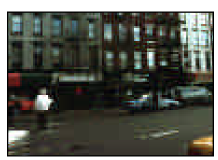
### Downtown Shopping Areas

Four pairs of images of downtown shopping areas were shown to determine people's shopping preference and their willing to travel further to shop at their preferred location. Five images were used in various combinations with two of them being digitally altered to be greener than the original slides. Where a difference in levels of green was obvious, the responses were heavily weighted towards the greener shopping district.

In the first two pairs of images 83% of the respondents selected the greener of the 2 slides (1B), with 9 people selecting the less green site in both questions. In the first pair the trees in the slide identified as greener are without leaf (no green vegetation visible). Although the other slide (1A) has no vegetation, it is the brighter of the two slides (more sky, more light and brightly colored walls) and was selected by 17%.

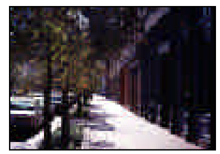


1A

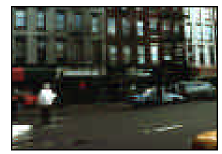


1B

The greener slide from the first pair was repeated in Question No.2, but was the less green one this time (2B). Only six of the 45 people who selected it as greenest in Question No.1, did so again in the second question. Perhaps it was not the presence of vegetation as to why they selected it the second time, but something else – such as that the storefronts being more visible in the angle of that picture than in the greener image.

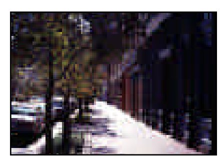


2A



2B

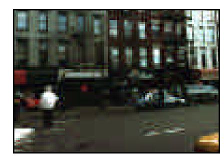
Question No.3 paired two images with similar amounts of green. When there were distinct differences in the amount of green found in images being compared, a distinct majority of people selected the greener slide. When images had similar amounts of green, the selection of images came closer to a 50:50 split. In this case 41% selected one image (3A) and 59% selected the other (3B), which was a digitally altered streetscape with an innovative design of two rows of trees and a visible ground cover.



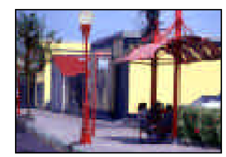
3A

3B

The fourth question paired the first two slides again, but the bright one without any green was digitally altered by replacing a chain link fence with a hedge, removing the crossing overhead wires, renewing the broken curb and planting young street trees. Although it was now rated to be the greener of the pair of slides, it was the only question in the entire survey where the majority of participants chose (4A) the less green option (65%) over (4B) the greener image (33%) and the only question of the downtown category that had a "no response". Perhaps the first stark vision of this image from Question No.1 was so prevailing that it influenced their selection in Question No.4. It could also be assumed that the difference between the original photograph and the altered photograph was not explicit enough for the respondents to notice the change.



4A



4B

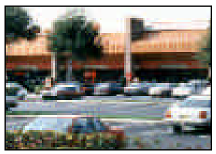
In three of the four questions in this series, 96% of the respondents expressed a willingness to travel to their selected shopping area, which indicates a WTP to shop at the greener downtown district. In the fourth question 87% indicated a WTP.

With each preferred choice, the majority of respondents (from 48% to 57%) indicated that they would be willing to travel from 5 to 15 more minutes to shop in the downtown district of their choice. An additional 7% to 13% of the respondents indicated that they would travel 15 to 30 minutes further to shop at the more preferred and greener sites. In question No.1 where the pair of images showed the largest contrast between green elements, it was the only question in the series where any respondents (9%) indicated a willingness to travel greater than 30 minutes. Two people (4%) did not respond to WTP in each of the first three questions and seven (13%) left the WTPin question No.4 blank, indicating that they were not willing to travel to shop at their preferred site.

## Suburban Strip Shopping Centers

The same analysis exercise as used for downtown areas was used for strip shopping centers in suburbia. Five slides were used in various combinations to form four pairs of images that respondents compared. They stated their shopping preferences, as well as their WTPas indicated by their willingness to travel additional distances to shop at their preferred choice. Once again when there was a distinct difference in the levels of green between the images being compared in a pair of photographs, the responses were heavily weighted towards the greener shopping center. In these comparisons, between 76% and 93% of the respondents preferred the greener option.

Question No.5, the first in the strip shopping center comparison series indicated that 80% preferred the greener shopping image (5A) and 5% did not make a selection. Although the slide rated as least green (5B) had no trees on site, mature trees were visible in the background of the slide. Additionally the architecture of the shopping center in the less-green image was more modern and reflected a style similar to many shopping centers that have been recently updated in the region. Therefore the architectural style could have been why 15% selected the site with less green in the image.


5A


5B

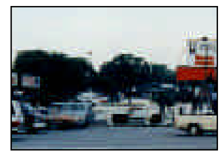
The slide with the lowest greening factor in the previous question was repeated in Question No.6 as the least green shopping center of the pair. Only three of the eight who selected it as the preferred site in the previous, selected it again as the preferred image. Of the two slides, the less green image (6B) once again had a more contemporary architectural style. It was selected by 24% of the respondents, with the remaining 76% selecting the greener image (6A) of the two strip shopping centers as they place they preferred to go to shop.


6A

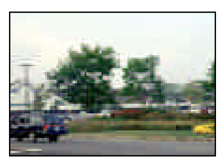

6B

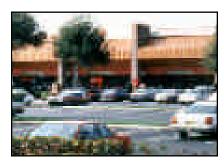
The next pair of images (Question No.7) compared two extremes in the amounts of green present. The greenest shopping center from the previous pair was compared to an old strip shopping center with lots of signs and no trees on site, but mature trees visible in the background off-site. The non-green site (7B) was a site adjacent to a road where you could drive in directly without traveling through a parking lot. 93% of the respondents selected the greener image(7A). Surprisingly enough two of the four respondents who selected the non-green image in this question had selected the greener images in all other questions.


7A


7B

The final pair of comparisons of images in this category (Question No.8) contained similar amounts of green on-site. Two people did not make a selection and two indicated they liked both images the same. The first image (8A) was selected by 56% of the respondents. It had a more contemporary architectural style and more mature trees, as well as a lawn element with a seasonal display of flowers. The second image (8B), which had been used in an earlier comparison as the greener of two slides, displayed a green hedge and trees in


8A


8B

the parking area. 40% of those who previously picked it as the preferred site selected it as the preferred site again.

From 91% to 96% of the respondents indicated a WTP by travelling further to shop at their preferred shopping centers, which were the greener images. Once again the majority of respondents (from 44% to 54%) indicated that they would travel an additional five to fifteen minutes to shop at their preferred site in each pair of slides. A five-minute journey was the next popular option with 33% to 44% of the respondents. 2% of the respondents would travel greater than 30 minutes to shop at the sites they preferred, which were ranked to be greenest or equal in green. When comparing shopping centers, the most people expressed their willingness to travel further than 5 minutes in Question No.7 (54% at 5 to 15 minutes and 9% at 15 to 30 minutes) where the images showed the greatest difference in the amount of visible landscaping. And in Question No.8 where both sites had an equivalent amount of landscaping, the greatest percent of people did not respond (9%), indicating that they would not be willing to travel.

## Suburban Shopping Malls

The final series of photographs in this section of the survey depicted suburban shopping malls. Malls differ from strip shopping centers in that they have exterior entrances to the mall with internal entrances to the stores and they generally carry higher end stores than strip centers. For many of the respondents strip centers are their local shopping areas, while malls are some distance away and visited for specific purposes other than day-to-day shopping.

Respondents were shown five pairs of images of shopping malls and asked to indicate their preference for each pair. They were then asked to express their willingness to travel further to their preferred mall. Five images of malls were used in different pairings to create the five pair. One photo was digitally altered by adding trees and flipping its viewpoint, while another was altered by adding cars, people and trees and by making the altered image closer in view.

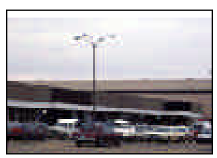
Four pairs of photographs (Question Nos. 9 to 12) showed malls with different levels of green. As in previous series when there was a distinct difference in the levels of green in a pair of images, the respondents more often preferred the greener option. In these comparisons, between 80% and 94% of the respondents selected the greener mall. Of all the images paired in the entire survey, these four pairs of slides showed the most disparity in landscaping. In Questions No.9 and No.10, the slide rated as the least green of each pair was void of any visible vegetation. The mall image with the least green in Question No.11 was repeated as the least green in Question No.12. It had five narrow trees next to the mall façade, but the photograph's foreground displayed an intense sea of asphalt.

80% of the respondents in Question No.9 preferred to shop at the greener of the two malls (9B). And five of the ten people who indicated that they preferred the less green mall (9A), selected the greenest mall in all other questions. Why might they have selected it? Although the non-green image in this pair was void of trees, it was a closer view and displayed less asphalt than the greener slide of the pair.


9A

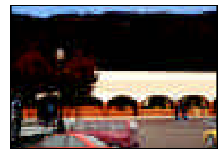

9B

94% of the people in Question No.10 preferred the greener of the two images – the highest percent of any question in the entire survey. In addition to the disparity of vegetation in the two images, their architectural façade was also quite different. The mall rated as the greener image (10B) also had a more modern architectural style. Both of these factors together could have caused more people to select it.


10A


10B

Question No.11 was the only one where the pair of slides compared an image of a mall against itself in a digitally altered format. One of the respondents was unable to choose between the two, perhaps because of their similarity. 83% preferred the image (11A) that had trees, people and cars added to it and less asphalt visible. Surprisingly five of the eight people, who indicated their preferred shopping mall to be the least green mall in this question, had selected the greenest malls as their preferences in all other mall comparisons. Although they selected the slide that was less green, it was obvious that their selection had not been digitally altered.


11A

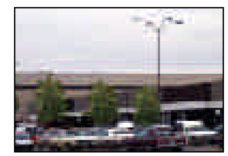

11B

89% of the respondents selected the greener image (12A) in Question No.12, which compared the greener image to the same slide that had been rated as least green in the previous question. Four more people than in the previous question selected the greener of the two images as their preferred mall to go to shop. Perhaps in this pairing where the mall façades were distinctly different, it was easier to compare and rank the images.


12A


12B

In previous questions where the compared images contained equal amounts of green, the respondents' preferences were not distinctly different. However, in Question No.13 where two mall images had similar amounts of green, respondents expressed a distinct difference in their preference. 78% of the respondents selected one mall over the other. The image (13B) selected by the majority had been the greener mall in two previous questions and had a more modern architectural façade. The image (13A) selected by the other 22% had been an image that was void of vegetation in an earlier comparison. For this pairing it had been flipped around and trees were digitally added. Perhaps the previous pairings of the two slides influenced the respondents' decisions to choose in favor of the slide that they had selected as the preferred site previously or against the one that they had not preferred prior to its alteration.


13A


13B

Between 91% and 96% of all of the respondents indicated they would be WTPby travelling further to shop at a preferred mall. The travel behavior of the survey respondents indicated that 50% of them travel from 15 to 30 minutes to shop at their favorite mall and an additional 15% travel more than 30 minutes to get to the mall. This series had more people (from 9% to 20%) willing to travel in the fifteen to thirty-minute range than the other comparison series (from 6% to 11%).

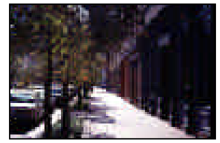
For three of the five questions in this series (Questions No.9, No.10 and No.12) the majority of respondents (50% to 56%) once again indicated their willingness to travel at least five to fifteen minutes to shop at their preferred mall. All three also had 4% unwilling to travel. 9% to 20% of the respondents would travel between fifteen and thirty minutes, whereas 20% to 32% would travel five minutes or less to shop at their preferred mall.

In the remaining two questions (No.11 and No.13) the majority of respondents (from 41% to 43%) would only travel an additional five minutes or less to shop at their preferred mall. But these two questions compared pairs of slides that had similar amounts of landscape or had the same mall compared to its altered version, making it harder to distinguish between the choices. In fact 9% of the participants, indicated they were not WTPby travelling in each of these two questions. Interestingly enough though, question No.11 (where the same mall was compared to its altered version) was the only one in this series where a respondent would travel more than 30 minutes to shop at the mall they preferred – the greener option.

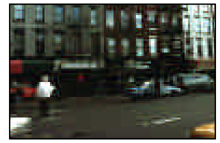
## Shopping Preference Groups

This section of the survey compared images with varying levels of greenness that were grouped in sets of four with the images rated from lowest amount of vegetation on-site to the highest amount or the greenest site in each set. Participants were asked to select their most and least preferred sites, as well as their WTP to travel to their preferred site. There was one set for each of the following categories: downtown shopping area, suburban shopping centers and suburban shopping malls. Higher percentages of the respondents agreed more often when selecting the least favorite site. In all cases the sites with a lower greenness factor were also the sites selected as least favorites and the sites with more green were selected as the most favorite places to shop.

In the set of downtown shopping area images 91% selected the two greenest images as their most favorite site to shop. The site that had a slightly higher green rating of the two was selected by 50% of the respondents (14C). This was a digitally altered innovative planting design. The second most common preference (41%) was a typical old city streetscape with trees in sidewalk pits and brownstone building façades (14A) . 96% of the respondents agreed that the two least green sites were also their least favorite places to shop. The image (14B) with the least green was chosen as least favorite by 33% of the people, whereas 63% selected the greener of the two low-green sites (14D) as their least favorite. Of the four slides, this slide (the greener of the two low-green slides) was the only image without a multi-story older brick or brownstone façade. Because the brightly colored one-story building was not typical of most commercial neighborhoods in New York City or other older New Jersey cities, it could be why it was selected as the least favorite site most often.

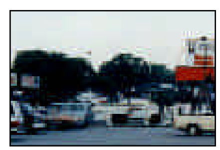

14A

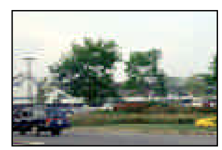

14C

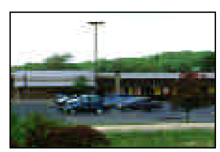

14B


14D

The favorite sites to shop at strip shopping centers reflected the same order as the greenness ranking for the set. 61% of the respondents selected as their most favorite shopping center the greenest image (15C) that had trees, shrubs, lawn and flowers. 24% selected an image (15B) with lawn and trees and the final 15% split their favorites between two images that had no trees on-site, but had tree canopies visible in the background. Aresounding 78% selected the same image (15A) to be their least favorite place to shop. This least favorite image was void of trees, was filled with lots of commercial signs and had direct access from the road.

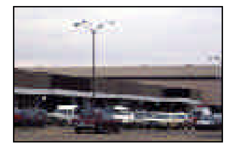

15A


15C


15B

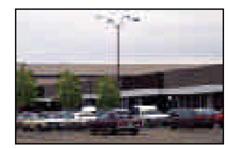

15D

In the final shopping preference set 57% of the respondents selected the same mall as their most favorite place to shop (16C). This image had the most parking lot trees planted in islands than the other three images. It was followed by another 33% selecting the only slide that had a mature spreading tree in the parking lot, along with small newly, planted trees (16B). The two slides with the least green were actually the same mall. The original was void of trees and was selected to be the least favorite place to shop by 89% of the respondents (16A). Although trees were added to the image that was also flipped over, 9% still selected it to be their least favorite (16D).


16A


16C


16B


16D

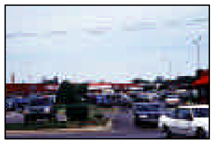
For Questions No.1 to No.13 only one person did not indicate any WTPand this respondent indicated that he/she did not shop at malls and only traveled between 5 and 15 minutes to shop at the grocery store once every 1.5 weeks. Others occasionally provided no response for a willingness to travel, but they were usually with images where the differing levels of green were not as obvious.

## Parking Lots

The final section of the IBVS looked at parking lots of commercial sites. Respondents were asked to view a set of images of four parking areas, then to select the one they would prefer to be as the parking lot for where they would shop. They also selected their least favorite from the same set. The surveys were held in late winter/early spring when people were not considering how hot their cars got after direct sun exposure in a parking lot. Therefore shade in a parking lot did not seem to influence their selections. It also seemed that the design or greenness of the site was not as much a factor as the amount of cars parked in the lot or the amount of vehicular motion in the image. 4% of the respondents did not select a most favorite parking area and 5% of them did not respond when asked to select their least favorite lot.

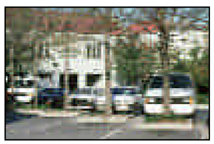
Fifty percent selected the greenest image (17D) that had shrubs and mature trees in planting islands as their preferred parking area. Another 37% selected the parking lot image (17C) that had trees in tree pits as their most favorite parking lot. This image had the second highest level of green.

The slide with the least amount of green (17B) was an empty parking lot that looked deserted. It was just a sea of asphalt with no islands or painted lines and 5 small narrow trees against the building façade. It was selected as the least favorite parking lot by only 33% of the respondents. However the slide with shrubs and ground cover in parking lot planting islands (17A) was rated as least favorite by 46% of the respondents. But why did more select it as their least favorite? Perhaps it was because that slide had the most motion expressed in the image. Cars were exiting into the street and moving through a lot that was filled with parked cars. So rather than the movement and number of cars indicating that this was a popular place to shop, the packed parking lots and traffic may have influenced their decision to not want to shop at the site.



17A

17B



17C

17D

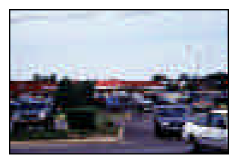
When asked about their WTPto travel to a nicer parking area when they shopped, 70% stated they would travel from five to thirty minutes. 2% would travel more than thirty minutes to get to their favorite parking lot, which was also the greenest of the four. 6% were not willing to travel. The remaining 22% would travel five minutes or less to a better parking lot.

The last part of the survey was to see if people were able to determine the type of commercial establishment of a site by looking at the parking lot design. A series of five parking lot slides were shown with four being from the previous question. For each image, a respondent could select from eight types of sites: discount stores, upscale mall, grocery store, strip mall, office park, restaurant, outlet shopping center, or hotel. They could select more than one type of site for each image. The responses indicated that people could make inferences about the type of commercial area associated with the parking lot.

The least green parking lot image that was a deserted sea of asphalt was selected by 25 respondents to be a strip shopping center, closely followed by an outlet center (24) and a grocery store (23).

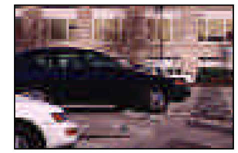
18B

The next greener image was the parking lot with the car-filled lot, lots of traffic, no shade trees, planting islands with shrubs and ground covers was selected most often to be related to a strip shopping center (33), a discount store (30), or an outlet center (21).



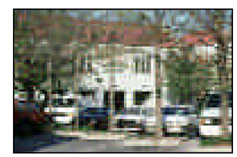
18A

The slide that was ranked next in greenness indicated the mid-range of greenness. It was an image that had not been shown before. The angled parking spaces had a small curb at the front of each space. There were shade trees along the edge of the lot, with shrubs, evergreen trees and ground covers as foundation plants near the building. The lot was half-filled with cars. 39 respondents selected this to be an office park lot and another 29 selected it as a hotel parking area.



18E

The second greenest parking area had angled parking with mature trees in individual tree pits and a wooded buffer of plants near the building. This image repeated the previous selections with 36 selecting it as an office park lot and 35 selecting it as a hotel lot.



18C

The parking lot in the image that was ranked as the greenest slide in the group showed evergreen hedges in planting islands and mature canopy trees. 35 people selected it to be the parking area of an office park and 32 selected it as an upscale mall lot. 28 respondents though it could be a hotel parking lot.

18D

Restaurants had the highest non-selection (18) of all the types of commercial businesses. When identifying patterns by looking at the number of times a respondent selected it, restaurants also had the lowest number of selections to link it with an image. Twenty people thought the greenest parking lot image could also be a restaurant lot.

In general the respondents linked the greener parking lots to the upscale malls, office parks and hotels, whereas the less green lots were associated with strip shopping centers, outlet centers and grocery stores. Restaurants seemed to be the most difficult to connect with a specific parking lot image. Perhaps it was because there are both upscale & low-end restaurants and the question did not specify which type it was.

## Image-Based Valuation Survey Conclusions

The Image-Based Valuation Survey (IBVS) was a successful tool that corroborated a connection between a shopping center's landscape and consumers' shopping preferences. While special amenities in shopping areas were probably not the most important consideration consumers use for selecting where to shop, people were able to differentiate between amenities and express which ones were more important to them. The majority of respondents selected trees and exterior landscaping – the green elements – as some of the most preferred amenities where they shopped.

The respondents were able to express their preferences based on hypothetical situations, using only photographic images as context for making their determinations. The majority of people selected the greener images as their preferred shopping area, whether it was a downtown street, a strip shopping center, or a suburban shopping mall. The greater the disparity of green between the images, the greater the number of people who indicated their preference of the greener image. Respondents seemed more readily to agree on their least favorite place to shop (low amount of green) when comparing images in a group. The lack of green elements was conspicuous and made it easier for them to select it as their least favorite. Where a difference in levels of green was obvious, responses were heavily weighted toward the greener shopping areas. But when the amounts of green were similar the selection between images was indistinguishable. Although the architectural style of the malls and shopping centers were important, people tended to select the greener option, even when the less green image had a more modern architectural style. When an image displayed a stylish architectural façade along with a high amount of green elements it had the highest selection percent.

More importantly respondents were able to state a willingness to pay more for their preferences, in this case through a payment mechanism of increased travel time. The majority of people were willing to travel further, thus hypothetically pay more, to shop at greener shopping areas when brands, merchandise and cost of goods were the same. Additionally the more clearly images were differentiated, the easier the decision was for the respondent and consequently, the higher the willingness to pay more for the preferred image. When compared images displayed comparable amounts of green, the WTP was less than when there was distinct differences in the amount of green. As the disparity in green elements increased, so did the WTP. The willingness to pay aspect was not without its limits. Few customers would travel longer than 15 minutes to shop at a greener shopping area. This last conclusion could be environmental. New Jersey cities and New York City had large numbers of shopping centers in proximity to one another and customers were not used to travelling further than 15 to 20 minutes to the site of their choice. This question in another part of the country may have elicited a different response.

In conclusion, the IBVS met its objectives and demonstrated the following:

- Customers did prefer green elements within commercial shopping areas;
- Customers were more likely to choose a greener shopping center, mall or downtown shopping district over one with less green elements; and
- Customers were willing to pay for this preferred level of green in a shopping area by travelling further to shop there.

# LOCAL CASE STUDIES

## Local Case Studies Summary

This phase of the study sought to determine the measured and perceived values of trees in the urban forests within selected commercial sites in both states. This was accomplished through a quantitative analysis of the trees in the commercial landscape using UFORE and CITYgreen, in addition to qualitative interviews that presented the perceived value of those same urban forests.

In New York City the existing urban forests in four Business Improvement Districts in Manhattan were analyzed. Along the US Route 1 corridor in New Jersey eight case studies were used to analyze the existing trees and forests at two hotels, three strip shopping centers, two shopping malls and one city improvement district with associated parking lots and the streetscape that connected it to the US Route 1 corridor. After the quantitative analyses were summarized for each case study, hypothetical growing simulations projected the value of the urban forests for ten, twenty or thirty years.

The anecdotal evidence provided by the staff and management of the commercial case studies indicated that management of commercial sites used green infrastructure to compete with others in obtaining tenants/merchants, new customers and repeat customers. Trees and other landscape elements were very important in the redevelopment of commercial sites, whether urban or suburban. The studies also showed that within the same type of commercial development, the newer ones were greener, especially in locations where the municipalities had higher standards for installing commercial landscapes, preserving trees and forests or replacing trees that were removed.

Ageneral review of the quantitative analyses results led to the realization that the planting or maintenance of an individual tree was not cost-justified on the benefits it provided – noise abatement, energy savings, air quality improvement and stormwater runoff reduction. Indeed most of the quantified benefits of trees were for public goods, not directly related to the economic benefit of the owners or managers of the sites. The exception being when the presence, size, health and location of trees allowed developers to build smaller on-site stormwater management systems, thus providing a cost savings directly to them.

Additionally the case studies indicated that although the benefits provided by one tree seemed insignificant, its benefits were readily visible when analyzed as part of a group of trees in an area. The growth projections demonstrated the importance of sustaining existing trees by providing long term care. The healthier and more mature the tree was, the more benefits it provided.

Although these case studies indicated that researchers could not precisely quantify the benefits that the trees and forestland provided, the anecdotal interviews indicated that management perceived the trees and landscape to contribute to their competitiveness and influence their economic success.

## Local Case Studies Hypotheses

The general hypothesis of this part of the study was that the green infrastructure on individual commercial sites or in business districts provide economic benefits to the region, as well as to the individual retail establishments. Existing studies indicated that street tree loss was typical in cities, especially in areas that were in decline or areas where there were a lack of funds to care for the aging tree resource. A related correlation was that the street tree planting rate would increase with commercial redevelopment projects in areas that were being revitalized; but only if the developers or local decision-makers embraced the value of the green infrastructure. It was also speculated that the planting of replacement trees was not usually a voluntary act by developers or managers, whether replacing valuable forested lands lost during new commercial development projects or replacing trees that died or were removed in commercial redevelopment projects. Rather planting replacement trees was based upon local requirements.

Additionally it was hypothesized that the greenest commercial developments had owners and/or management that linked their level of onsite landscaping with their ability to compete with similar retail establishments for customers and/or tenants. And finally it was hypothesized that if sites with little or no vegetation were improved by adding to or enhancing its landscape with trees, they would increase their ability to compete for customers and/or tenants, while adding to the quality of life in the region.

Existing studies indicated that street tree loss was typical in cities, especially in areas that were in decline or areas where there was a lack of funds to care for the aging tree resource. Researchers were unable to corroborate this hypothesis, because they were unable to get information about tree loss in the BIDs. On the other hand, it was hypothesized that street tree planting rates increased with commercial redevelopment projects in areas that were being revitalized; but only if the developers embraced the value of the green infrastructure or the local policies and regulations required it.

## Local Case Studies Objectives

The objectives of analyzing local case studies were to:

- Identify the main influences that determine the amount of landscape investment of the selected commercial properties;
- Determine the perceived value of green commercial sites by the developers and/or property owners; and
- Quantify the benefits that trees and forests on selected commercial sites provide to the region.

## Local Case Studies Methodology Background

As in *Part Two*: *The Regional Trend Analysis*, the two quantitative analysis methodologies used in the local case studies were UFORE and CITYgreen. These scientific models measured and identified the economic value of the environmental benefits of trees in the urban forests on selected commercial sites. Although it was known that the physical vigor of trees influences climate and air quality by providing shade, absorbing ultraviolet light and transpiring, there were no available models that could calculate this value for the cooling of the ambient air in large paved parking lots. This would have been extremely helpful in the study, because large impervious parking areas existed in most of the case studies. The selected models analyzed the environmental benefits of trees and urban forests, including air pollution removal, stormwater runoff mitigation, energy conservation of directly–shaded buildings and the storage and sequestration of carbon.

The USFS modeling technique UFORE and American Forests'CITYgreen software were described in detail in the background methodology of *Part Two*: *The Regional Trends Analysis*. Whereas only CITYgreen was selected for the regional analysis, both models were used in the local case study analyses, whenever possible. The parallel use of both CITYgreen and UFORE models allowed the comparison of results obtained by using different levels of site-specific input data. In general, CITYgreen relied on simplified assumptions and generalized inputs so that the product can be widely used by people with little knowledge of modeling and with minimum data input requirements. By contrast UFORE required more data collection and used site specific inputs (e.g. meteorological and air pollution data actually collected within the region), thereby generating more accurate results.

*Accessibility and Ease of Use* – Although UFORE was more accurate for local analysis, it was not popularly accessible. CITYgreen was easily accessible and required less data collection. Its ease of use with minimal inputs, its minimal required processing time, its ability to estimate regional benefits and its ability to create colorful maps has increased its popularity as environmental modeling software. Because of the software local researchers rapidly estimated the carbon and air pollution benefits. UFORE analysis was more time consuming, because it was not in a user-friendly format. A local team collected data and delivered it to the USFS in Syracuse, New York, then the USFS conducted the analysis with the appropriate UFORE modules and returned the results to the study team. Additionally, because CITYgreen (CG) was on-site, it allowed the researchers to calculate benefits based on different scenarios – the growth of existing on-site trees over defined time periods and the analysis of various what-if scenarios based on different amounts of trees planted.

*Forest Patches/Woodlands (CG only)* – UFORE did not generate data for tree stands or forest patches that were not specifically inventoried. The UFORE models required representative individual tree data in order to include forest patches in the UFORE analysis. Thus UFORE analysis was limited to sites or portions of sites where all trees were inventoried. CITYgreen, on the other hand, allowed the inclusion of forest patches, described as larger naturally forested woodland areas that were not inventoried on an individual tree basis. CITYgreen accepted these generalized factors for forest composition in its analysis of forest patches or suggested simple extrapolations of local analysis to regional scales. If the assumptions were incorrect, these extrapolations could cause a multiplication of errors effect.

*Carbon Storage Capacity and Carbon Sequestration Rate (CG, UFORE-C)* – CITYgreen incorporated UFORE-C, the USFS Carbon Storage and Sequestration Module, in its program. Therefore both methods measured the carbon storage capacity of trees – the amount of carbon stored within the tree's biomass from the removal of atmospheric carbon dioxide, a greenhouse gas. They also calculated the sequestration rate – the rate at which the carbon storage process occurred. However, neither model placed an economic value for either the rate or the storage capacity. The diameter of the trunk (diameter at breast height – DBH) and the diameter of the canopy of the individual trees on site were used for these calculations.

*Air Pollution (CG, UFORE-D)* – The CITYgreen software incorporated UFORE-D, the Air Pollution Removal module to estimate the value of trees in removing air pollutants – Nitrogen Dioxide ($NO_2$), Sulfur Dioxide ($SO_2$), Ozone ($O_3$), Carbon Monoxide (CO) and Particulate Matter less than 10 microns (PM10). The pollution removal rate was based upon the area of tree canopy coverage on the site, along with regional data collected from various sources. Although CITYgreen and UFORE used the same module for calculation (UFORE-D), the regional data and the level of on-site data collected for each caused slightly different results. CITYgreen used more generalized annual meteorological and air pollution deposition factors. Calculations for the New Jersey sites were made based on the average of this generalized data for eight cities from across the nation that were listed in CITYgreen's database. For the New York City sites the New York City data was selected from the CITYgreen database. Alternatively UFORE incorporated local hourly meteorological and pollution-concentration data from local monitoring stations. The UFORE analyses performed during this study on sites within New Jersey were based on weather data from Newark, NJ and average pollution data for New Jersey (1994). UFORE analyses of New York City BID sites used weather and pollution data for New York City (1994).

In both CITYgreen and UFORE the monetary value of the pollution removal by trees was estimated using median externality values for the United States for each pollutant. These monetary values were developed by state and federal environmental agencies as a means to quantify the net cost to society of a given amount of air pollutant emitted.

*Stormwater Runoff Reduction Rates (CG only)* – Using algorithms based on the USDATR-55 stormwater models, CITYgreen quantified how land cover, soil type, slope and precipitation affected stormwater runoff volume, time of runoff concentration and runoff peak flows within the region. (Stormwater was not addressed within UFORE.) Individual tree data (height, trunk or canopy diameter, height to bole, etc.) was not used for this calculation. The USDATR-55 model used a variety of land cover types, not just forest cover to determine the effects. CITYgreen calculated the volume of runoff that would need to be contained by stormwater retention basins if the onsite vegetation were removed. A monetary value for the calculated reduction was estimated by using the ability of tree cover to mitigate stormwater management requirements. (For more detailed information on the stormwater management calculation, see the Urban Forest Benefits Quantification in *Part Two: Regional Trend Analysis.)*

*Energy Conservation (CG only)* – The CITYgreen software estimated energy conservation associated with trees in the City of Trenton where the trees were within 35 feet of two-story buildings. Data including tree height, canopy and solar orientation of the buildings were used for this calculation. This interpolation was considered unsuitable for use at most of the sites within the study because the buildings were not within 35 feet of the trees or were greater than two-stories.

*Intrinsic Value of Trees (UFORE only)* - The net worth (intrinsic value) of trees on the sites were calculated based on ISA (International Society of Arboriculture) tree formula values developed by the Council of Tree and Landscape Architects. These calculations used the data collected for each tree – diameter, species and health.

*VOC Emissions (UFORE only)* – UFORE-B estimated the negative biogenic volatile organic compound (VOC) emissions from trees – emissions shown to contribute to ozone formation. These negative effects must be weighed against the trees'beneficial ability to reduce ozone when determining the net air quality effects.

## Local Case Studies Methodology

Commercial sites in both states were selected as case studies. The perceived values of the trees on most of the commercial properties were extracted from the commercial property owners and/or developers, while the private and public benefits of the trees on all the selected sites were quantified. First developers, owners or business improvement district managers/staff of the sites chosen as case studies were interviewed to determine the qualitative values they placed on their respective commercial property's landscape. The final step in the case study analysis quantitatively measured the benefits of trees on the selected sites using GIS software and hypothetical growing simulations.

## Site Selection Process for New York City Business Improvement Districts

It would have been very difficult to consider every business district or individual commercial enterprise in New York City as a potential case study site. Therefore Business Improvement Districts (BIDs) were identified as potential New York City commercial case studies. BIDs formed a sample that represented the diverse nature of commercial districts in New York. They were also defined districts with groups of commercial entities, which allowed researchers to study them as a group of businesses, rather than as isolated businesses. As a sample population they had active redevelopment activities that were intimately involved with external aspects, including greening efforts that could be evaluated. BIDs were familiar with the impact of many variables that effected the financial success of an area. They had analyzed pedestrian traffic, customer perceptions and landscaping costs. BIDs also had a specific point person for a district, which made it easier than it would have been if researchers had to contact a different person for each commercial establishment.

BIDs were not a phenomenon specific to New York City (NYC). They were being established in various formats in cities across the country to revitalize their commercial districts, including the Mercer County Arena Improvement District, which was selected as a New Jersey case study.

The City of New York created BIDs as non-profit corporations to develop and administer revitalization and self-improvement programs within a defined geographical area. BIDs were mostly financed through special assessments collected by the city and returned to the BIDs. In essence, they levied a tax on area businesses to pay for the services they provided. These assessments were based on the economic classification of the area and the ability to pay the tax combined with the improvements and services that each BID was established to provide. These assessments ranged from 15 to 23-cents per square foot. BIDs also received support from the private sector for programs, events and services. BIDs enabled property owners, tenants and city officials to work together to revitalize commercial districts. These public-private partnerships included city agencies, private businesses, community boards and other not-for-profit organizations.

The two primary goals for each NYC BID were to provide area improvements that maintained or upgraded the ability to do business and provided security. Most BIDs had security forces, clean up crews and anti-graffiti patrols. In some districts, social services were provided to homeless men and women. Many BIDs were active in beautification efforts. Some offered consulting services to retailers to improve store display windows and interiors. BIDs were also concerned with street furniture and street lighting. Some of the larger BIDs collected data about the activities in their districts and made results available to the retail and commercial members of the BID, as well as to potential merchants thinking of relocating to the district. The BID approach has been credited with improving conditions in commercial districts and transforming dilapidated crime-infested neighborhoods into clean, safe and successful business districts.

At the time of the study there were forty BIDs scattered throughout four of NYC's five boroughs/counties; too many to include all of them as case studies. Aerial photographs of the NYC BIDs were not available with a resolution high enough to detect the presence of individual street trees – the major element of the urban forest in the commercial districts. Therefore the amount of green infrastructure in the districts could not be used to select potential case studies. To consider which of the forty BIDs had potential appeal as case studies, it was decided to develop a questionnaire to gather information about them. Each BID had an identifiable individual with knowledge of their commercial district who could provide information through a questionnaire. The final case study selections were made based upon the responses to the mailed survey.

In February 1999 a questionnaire was designed (Appendix D) and sent to all forty NYC BIDs. The objective of the questionnaire was to discover how much the BID Directors valued the landscape elements in their area and how much of their budget was invested in planting and maintenance. After analyzing the information from the returned surveys, BIDs were selected for case studies. They were chosen on the following basis:

- BIDs from one borough/county. This made comparison easier as similar rules and constraints govern these BIDs. For example each borough had their own forestry division with differences that ranged from species restrictions to inspection procedures.
- BIDs that were typical of downtown areas in other cities with a diversity of user populations and a diversity of types of commercial enterprises.
- BIDs within one metropolitan area that provided a geographical representation of districts.
- BIDs that considered landscaping an important feature of their development area.
- BIDs with varying landscape budgets. This gave an opportunity to assess whether the size of a landscape budget made any significant difference.
- BIDs with an interest in participating in the study and who were able to provide access to information requested.

Fifty five percent of the BIDs responded to the survey and of those respondents four were selected from Manhattan Borough (County) as case studies for further analysis:

- 47th Street BID
- 8th Street Village Alliance BID
- Bryant Park Restoration BID
- 34th Street Partnership BID

## Site Selection Process for New Jersey

Researchers felt that the low response rate expected from a survey mailed to commercial enterprises along the Route 1 corridor would not be representative. Additionally an individual contact was not identifiable for every commercial site. For example managers were often responsible for maintenance only and the head office of the chain or the owner of the franchise oversaw any landscape planning or changes.

Therefore purposive sampling was used to select sites for case studies in the same study area used for the regional trend analysis – along the US Route 1 corridor between Trenton and New Brunswick. Although some of the study area consisted of office parks, isolated offices, or isolated manufacturing areas, researchers decided to select case study sites in two commercial categories: hotels and shopping centers. The other commercial classifications were found to have too many factors, both identifiable and not, that influenced tree prevalence and might effect consistent comparison. The two selected commercial categories had a steady influx of customers that visited the sites daily, plus there was competition along the US Route 1 corridor for these types of customers.

The general intent was to study at least two sites in each of the selected commercial categories – one being representative of the highest level of green infrastructure for that category of commercial site in the study area and the other with the lowest level. Other factors came into play though.

The International Council of Shopping Centers (ICSC) defined a Shopping Center as "a group of retail and other commercial establishments that are planned, developed, owned and managed as a single property. On-site parking is provided. The center's size and orientation are generally determined by the market characteristics of the trade area served by the center." Malls and strip centers were the two main configurations analyzed in the study.

Only two commercial properties in the study area met the ICSC definition of Mall. A typical mall was defined as an enclosed shopping center with a walkway that is climate-controlled and contains two strips of stores that face one another. Although there are many types of malls (super-regional, outlet, neighborhood, etc.), this study only considered sites with the basic configuration of a mall, not its type. Thus the two mall case studies selected were:

- Market Fair
- Quaker Bridge Mall

In order to select case study sites for the other two classifications – strip shopping centers and hotels – the tree coverage percent was measured for all the sites of those classifications. The most current available (1995 or 1997) hard-copy aerial photography at a scale of 1-inch: 400-feet was used to determine the percent cover of the landscape trees and the woodlands on the sites. Then researchers selected those with the highest or lowest on-site green index.

Strip shopping centers, as defined by the ICSC are "an attached row of stores or service outlets managed as a coherent retail entity, with on-site parking usually located in front of the stores. Open canopies may connect the storefronts, but a strip center does not have enclosed walkways linking the stores. A strip center may be configured in a straight line, or have an "L" or "U" shape."

Based on the green indexing process researchers selected three sites as strip center case studies:

- Brunswick Shopping Center (North Brunswick)
- South Brunswick Square Mall (South Brunswick)
- Lawrence Center (Lawrence)

Both Brunswick Shopping Center and Lawrence Center were older strip centers with the lowest amounts of landscape trees and no trees in the parking lots. Both sites were chosen as a case study to represent the least green, not only because each had no parking lot trees in their original layout, but also because each had undergone recent landscaping improvements, which included parking lot trees. These improvements allowed good modeling opportunities using actual changes to the landscape. South Brunswick Square Mall had a high percentage of total upland tree cover, as well as the largest amount of landscape trees in the parking lots, detention basins and buffer areas, therefore it was selected to represent the shopping center with the highest amount of green infrastructure.

The US Route 1 corridor had numerous hotels, many being the business or extended-stay type. Two sites were selected for further analysis:

- Courtyard by Marriott (Plainsboro)
- Marriott Residence Inn (South Brunswick)

Within the Hotel classification, our analysis indicated that level of tree canopy was quite similar on all hotel sites. Since there was no distinctive high or low green infrastructure ranking for this classification, researchers looked at the potential for an interesting case study. Courtyard by Marriott could not be measured in the same manner as the others, because it was a newly constructed hotel that was not visible on any available aerial photos. Researchers selected it as the hotel representing the least amount of green infrastructure, only because it was a recent construction with small, newly planted trees forming the tree canopy. It also offered a good opportunity to model tree benefits as the newly planted same age trees matured. Plus there was the potential to obtain current landscaping costs from the developers or township.

The Marriott Residence Inn was chosen as the comparison hotel, due to the relatively large amount of landscape trees planted both on the open areas of the site, as well as between the individual hotel units. It was also representative of the extended-stay type of hotel that is prevalent in the region. Another site actually had a higher amount of tree canopy in the hotel category, but the majority of it was a wooded wetland that could not have been developed because of wetland restrictions, not because of the value that the developer placed on these woodlands.

The energy conservation modeling could not be used for shopping centers or hotels because the modeling functions in CITYgreen were only applicable to the direct shading of a tree within 35 feet of a one or two-story building. With the US Route 1 corridor study area being bounded by two older cities, researchers searched for a site in either of the two cities that would be appropriate for this type of analysis. Researchers selected 3.5 miles of streets in the City of Trenton that had appropriately-sized commercial buildings where the energy conservation model could be used and it also passed through an urban improvement district where redevelopment was occurring that included the planting of trees. The local and county government worked together on the selected Mercer County Arena Improvement District. Five parking lots within the district were also selected as part of a case study.

## Subjective Valuation

The perceived values of trees on commercial properties were extracted from qualitative in-depth anecdotal interviews of the commercial property owners and/or site managers. The interviewees answered researchers' questions about their respective commercial property's landscape. Interviews were chosen as the method to obtain detailed information about influences and actions in BIDs, shopping centers and hotels because they allowed researchers to:

- Discover the main objectives, main influences and perceived impacts with respect to landscaping on their site;
- Probe deeper and seek clarification, which was not possible with a questionnaire; and
- Follow the line of questioning into new areas not considered prior to the interview.

The interview method concentrated on four BID districts, one urban improvement district, five shopping centers and two hotels. It can be argued whether the results and conclusions were representative of a larger population. The chosen BIDs were at different stages of re-development and managed budgets of different sizes. The shopping centers represented a cross-section of retail developments in the study area from a local community center to a high-end lifestyle center and a super-regional shopping center. The hotels were representative of the greening found of hotels in the study area. Interviews confirmed this homogeneity and assessed what external influences could be brought to bear on the industry standard.

In New Jersey the researcher contacted the appropriate manager by fax with an outline of the study and then followed-up with a telephone call to request an interview. Some interviews were carried out during this call. Others were interviewed by the researcher in-person on the commercial site. In New Jersey researchers were unable to obtain an on-site or telephone interview at three sites. One because researchers were unable to make direct contact with the owner/managers who were out-of-state. Managers of the two other sites, who had originally agreed to participate in the study, did not follow through with the interview portion of the analysis because of scheduling conflicts. All three sites were included as case studies without any perceived valuation, only a quantitative analysis.

In New York City five BIDS were selected. They were contacted via telephone and personal interview appointments were made. One of the selected sites was deleted as a case study because researchers were unable to get needed data or an interview. The four on-site interviews were an in-depth follow-up of the initial survey that had been sent to all the BIDs. Two BID Directors and one staff horticulturist were interviewed. The staff horticulturist talked about two separate BIDs, the 34th Street partnership and the Bryant Park BID. The four BIDs chosen for interviews commanded different budgets, had different concerns and different structures of staff and advisors. All three interviewees agreed that landscape was an important element in the overall improvement of the particular district.

The two researchers doing the interviews, Margaret O'Gorman in New Jersey and Susan Gooberman in New York tried to obtain the same amount of information from each interviewee. However each respondent had different levels of knowledge about their site and the green infrastructure within it. Follow-up calls were made to try to obtain additional information. Although the results were subjective, they were very important to understanding what recommendations needed to be made to make changes in the commercial development and redevelopment processes.

## Quantitative Analysis and Simulation Techniques

In addition to collecting data about the perceived value of the trees on the case study sites, a quantitative analysis was performed to measure the environmental benefits of the on-site trees. In order to quantify the values of the urban forests on the commercial sites, researchers performed site analyses and simulations for each of the selected case study sites in New Jersey and New York City.

Maps, aerial photographs and site data were collected for the Geographic Information System (GIS) analysis. Site features were digitized in ArcView GIS. Property boundaries were then digitized based on the hardcopy tax maps and tax records. Because of the overlay of data from hardcopy maps into the orthophotography layer there were certain discrepancies as to exactly where property boundaries were. Buildings, impervious surfaces, water bodies and forest patches were digitized into ArcView GIS based on the NJ DEP1995/1997 aerial orthophotographs with reference to site plans when available. Then data collection teams collected on-site data about the trees and land cover. Finally, from the collected data the individual trees were digitized into the GIS and the associated tree attribute data was entered into database tables.

A three-person data collection team visited each New Jersey case study site. One of the members was the person who would enter the data for the GIS analysis. The other two were proficient in tree identification and tree measurement techniques. Additionally one would be analyzing the data and writing about the methodology and analysis. At the New York City sites two people collected the tree data.

Prints made from NJ DEP1995/1997 aerial orthophotographs of each NJ site were used to mark the location of the trees on-site and to make notations as to the surface underneath the trees. Trees were located on the map and given an identification number. The corresponding number was listed on a data collection form (Appendix E) where data was recorded for each tree. No maps were used to locate trees on the NYC sites, only tree information was collected for each street tree in a BID. The following data was collected for the trees on every site:

- Tree Species (common name and scientific name)
- DBH – Diameter at Breast-Height (measured in inches at 4-feet above ground)
- Total Tree Height (estimated to the nearest 5-foot measurement)
- Bole Height (height to live crown in feet; only used for UFORE modeling)
- Crown Diameter (average width of tree canopy in feet)
- Health (condition based on die-back; UFORE and CITYgreen used different scales)
- Ground Cover (predominate cover under tree)

To establish an economic value for the urban forest on each site, Jon Raser of Cedar Lake Environmental performed various analyses using CITYgreen. Additionally the USDA Forest Service's Northeastern Forest Experiment Station in Syracuse, New York processed and analyzed the collected site data, then returned the results to the study researchers. The parallel use of both the CITYgreen and UFORE models allowed the comparison of the results obtained from the usage of different levels of site-specific data input and helped to validate the results of the quantitative analyses of the benefits. The UFORE analysis used all the same collected tree measurements as in CITYgreen, except that it also required the height to bole so to more accurately calculate the 3-dimensional leaf surface of a tree's canopy. Additionally the calculated amounts of pollution removal were based on more generalized data in CITYgreen and more site-specific meteorological data in UFORE, as explained in *Part Two: Regional Trend Analysis.*

CITYgreen and/or UFORE measured and calculated the following beneficial values provided by the trees and forests on commercial sites:

- Stormwater Reduction
- Carbon Storage
- Carbon Sequestration
- Air Pollutant Removal
- Intrinsic Value

In addition to calculating the beneficial values of the existing trees, CITYgreen modeling allowed the maturing (grow-out) of the existing trees on site and estimated their projected values over time. The existing trees on each New Jersey site were grown out and their values projected for ten and twenty years into the future. In the Trenton parking lots thirty-year grow-out scenarios were used based upon the existing trees planted and the minimum number of trees required to be planted in a parking lot as per local ordinances.

For the grow-out modeling in New York City researchers estimated the maximum number of street trees that could be planted in a BID based solely on the linear feet of street. This was without knowledge of any limitations, such as signs, doorways, underground utilities or vaults. Researchers calculated the maximum number of street trees that could be planted in each BID using the following formula. The total linear feet of streets in a BID multiplied by 2 (for each side of the street) minus 40 feet for each intersection divided by 25 feet (the selected spacing for the street trees) minus 25% of the subtotal (for errors including unknown vaults, fire hydrants and other traffic signs) equals maximum number of street trees that could be planted in a BID. Researchers kept the same species of trees in the same percentages as the existing trees. Then they matured the potential trees in each BID over ten and twenty year periods. The exception was the 47th Street BID, which had no trees. Because the number of proposed trees for that BID was similar to the existing number of trees in the 8th Street BID, researchers used a similar species mix to project the benefits to trees in the 47th Street BID.

The annual air pollution removal rates for the existing trees within each study area were calculated using both UFORE and CITYgreen, except for the City of Trenton sites and the Courtyard by Marriott site, where only CITYgreen was used. When air pollution removal and the associated values were calculated, only the CITYgreen results included forest patches, which could not be grown out in the modeling process. Therefore researchers used CITYgreen to mature the individual trees during the grow-out modeling process, then added the existing value of the forest patch as a constant to each grow-out model's projected total.

In addition to the rate of removal and the amounts removed, both models provided an associated economic value for the removal of each of the following air pollutants:

- Ozone ($O_3$)
- Sulfur Dioxide ($SO_2$)
- Nitrogen Dioxide ($NO_2$)
- Particulate Matter less than 10 microns (PM10)
- Carbon Monoxide (CO)

Additionally both models calculated the carbon sequestration rate and the carbon storage capacity of the trees on every case study site. The carbon storage amounts showed disagreements between UFORE and CITYgreen. In the carbon calculations only CITYgreen allowed the inclusion of forest patches. Once again researchers used CITYgreen to mature the individual trees during a grow-out modeling scenario, calculated the benefits, and then added the value of the existing forest patch to the grow-out model's total.

Only the CITYgreen model calculated the volume of runoff that would need to be contained by stormwater retention basins because of the removal of vegetation. It provided a monetary connection to the ability of tree cover to mitigate stormwater management requirements for each site by reducing the amount of on-site runoff. The monetary value was related to the one-time cost savings for constructing on-site stormwater management systems at the time of development.

On the other hand only the UFORE results provided the intrinsic value of the trees in every case study. And only UFORE calculated the amount of Volatile Organic Compounds (VOCs) emitted by the on-site trees – a negative impact that would reduce the beneficial values provided by the urban forests. A monetary value was not assigned to the VOCs emitted by the trees; thus the total beneficial value of those trees was not reduced. However, it should be considered when looking at the value of the urban forests on each site. The biogenic VOC emissions (ozone precursors) indicated on certain sites severely impacted the net ozone benefits of those trees. These biogenic VOC emission levels varied widely between tree species. It should be noted that in areas where there are high amounts of pollutants, low-emitting VOC trees should be considered for planting.

The Energy Conservation modeling functions in the CITYgreen program were only used to understand the energy conservation benefits of the street trees in 3.5 miles of streets in the City of Trenton. It was not applicable because of building height or proximity of on-site trees to buildings and therefore was not calculated for any other sites in either state.

The quantitative analysis was summarized for each case study. It allowed the comparison of quantitative values calculated using different models and the comparison of current quantitative values with projections of the values based on hypothetical growing simulations.

*Data Collection Team*

## Local Case Studies: Site Descriptions, Simulations, Analysis and Findings

### Shopping Mall Case Studies

The two malls selected as case studies were enclosed shopping centers with climate-controlled walkways and two strips of stores facing one another. Quaker Bridge Mall and Market Fair were the only two malls within the study area.


## QUAKER BRIDGE MALL

**Case Study Conducted:** May 1999 to December 1999
**Interviewees**: Mr. John Ferreira, General Manager of Quaker Bridge Mall
Andrew Link, CLA, PP, Lawrence Township Landscape Architect
**Address:** 150 Quaker Bridge Road, Lawrenceville, NJ 08648
**Location:** The mall was situated on the northbound side of US Route 1, 1 mile north of I-95/I-295 and 20.5 miles south of Exit 9 of the New Jersey Turnpike. It was in Lawrence Township and abutted the southwestern border of West Windsor Township along Quaker Bridge Road/Province Line Road. It was also accessible from Quaker Bridge Road and Meadowbrook Road.

### General Site Description

Quaker Bridge Mall is an enclosed 1,291,055 square foot 'Super Regional Mall'located in Lawrenceville, NJ. The mall was built in 1976 and has been updated since 1995. The mall is a two-story building located on 105 acres of land next to US Route. 1. The mall has 5,592 parking spaces for the 1,040,000 vehicles using it every year. 2.6 million customers per year visit the 120 stores. Of the 1,291,055 square foot of space 55% is used by the four main anchor stores, 31% by other mall stores, 13% is common area with the remaining space used for storage and administrative offices. The four anchor stores are JC Penney, Lord & Taylor, Macy's and Sears. (figure 4.01)

| Quaker Bridge Mall Site Facts | |
|---|---|
| Area of Site | 104.57 acres |
| Area of Site | 0.16 square miles |
| Parking spaces | 5,592 spaces |
| Impervious Surface | 78.1% |
| Building Area | 18.14 acres |
| Paved Area | 63.52 acres |
| Pervious Surface | 21.9% |
| Water Surface | 2.47 acres |
| Tree Canopy Area* | 6.15 acres |
| Forest Patch Canopy Area** | 0.00 acres |
| Sampled Trees | 1,177 trees |
| Tree Species (without forest patches-FP) | 22 species |
| Tree Density | 13.62 trees/acre |
| Average Tree Ht (without FP) | 21.0 feet in Ht |
| Average Tree DBH (without FP) | 8.9 inch DBH |
| Average Tree Health*** (without FP) | 3.4 ratings |
| Intrinsic Value of On-Site Trees | $1,380,474 |
| Tree Planting Cost (estimated by management) | $600 /tree |
| Landscape Maintenance Cost (est. by mgmt.) | $125,000 /year |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.01*

## Urban Forest and Landscape Amenities Description

- The Quaker Bridge Mall site had 1,177 trees of 22 species planted throughout the site, which created 6.2 acres of canopy (6% coverage) over the 105-acre lot.

- Most of the onsite trees were planted as buffers to hide delivery areas, parking lot trees to define interior traffic patterns, detention basin plantings and boundary plantings to soften views of the large barren parking areas from the people traveling on the surrounding roads.

- Landscaping efforts adjacent to the building were concentrated around the entrances to the common areas of the mall. These entrances were being upgraded as part of an upgrade project that commenced in 1995. Each year a different entrance is upgraded with new trees, shrubs, ground covers and planters.

- Some years ago larger overgrown trees and shrubs were removed from the site due to safety concerns expressed by the customers.

- Management planned to continue upgrading common entrance areas with tree and shrub plantings, but no new trees were planned for the wider area of the parking lot.

- Although the mall management indicated there were no plans for planting trees in the parking lot or along the interior mall roads, the project's data collection team discovered newly planted trees after returning to the site to confirm data they had collected earlier. A number of trees in the lots and along the interior roads that had been noted as dead or in poor health on a previous site visit, were now gone. New trees were planted in place of some of the removed dead trees, whereas other dead trees had been removed and were in the process of having their stumps ground out. (The data used in this study reflects the newly planted trees from the final site visit, rather than the dead or dying ones from previous data collection site visits.)

- The interior landscape was a mix of trees and planted baskets. Plans were underway to remove much of this landscaping in response to an ongoing trend in shopping center design to remove unwanted obstructions and to lower maintenance costs.

**Quaker Bridge Mall Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Acer platanoides | Maple, Norway | 42 | 3.6% |
| Acer rubrum | Maple, Red | 130 | 11.0% |
| Acer saccharinum | Maple, Silver | 1 | 0.1% |
| Acer saccharum | Maple, Sugar | 41 | 3.5% |
| Cedrus atlantica | Cedar, Atlas | 3 | 0.3% |
| Cercidiphyllum japonicum | Katsura Tree | 13 | 1.1% |
| Chamaecyparis sp. | Falsecypress | 6 | 0.5% |
| Cornus florida | Dogwood, Flowering | 1 | 0.1% |
| Fraxinus pennsylvanica | Ash, Green | 149 | 12.7% |
| Gleditsia triacanthos var. inermis | Honeylocust, Thornless | 156 | 13.3% |
| Malus spp. | Crabapple | 50 | 4.2% |
| Picea abies | Spruce, Norway | 6 | 0.5% |
| Picea pungens | Spruce, Colorado | 1 | 0.1% |
| Pinus nigra | Pine, Austrian | 88 | 7.5% |
| Pinus strobus | Pine, Eastern White | 241 | 20.5% |
| Pinus sylvestris | Pine, Scotch | 1 | 0.1% |
| Platanus x acerifolia | Planetree, London | 78 | 6.6% |
| Prunus serrulata | Cherry, Japanese | 76 | 6.5% |
| Pyrus calleryana | Pear, Callery | 6 | 0.5% |
| Quercus palustris | Oak, Pin | 23 | 2.0% |
| Quercus rubra | Oak, Red | 18 | 1.5% |
| Tilia cordata | Linden, Littleleaf | 47 | 4.0% |
| | **Total Tree Count** | **1,177** | **100.0%** |

*figure 4.02*

- 28% of the 1,177 trees on site were a species of pine used for screening views – buffer areas. This was a high percent of one species to have on site. If disease or pests attacked the pines, the buffer areas could be immediately decimated. The Austrian Pine on site were examples of this, as all were suffering from tip blight.

- 37% of the trees were a mix of three shade trees – green ash, honeylocust and red maple – with only 11% to 13% of each species. The other 35% were a mix of sixteen species of trees. (figure 4.02)


*Shaded parking spaces were filled even though people had to walk further to entrances.*

*Large areas of pavement without landscaping away from buildings.*

## Perceived Value of the Urban Forest and Landscape Amenities

**To Mall Manager**:

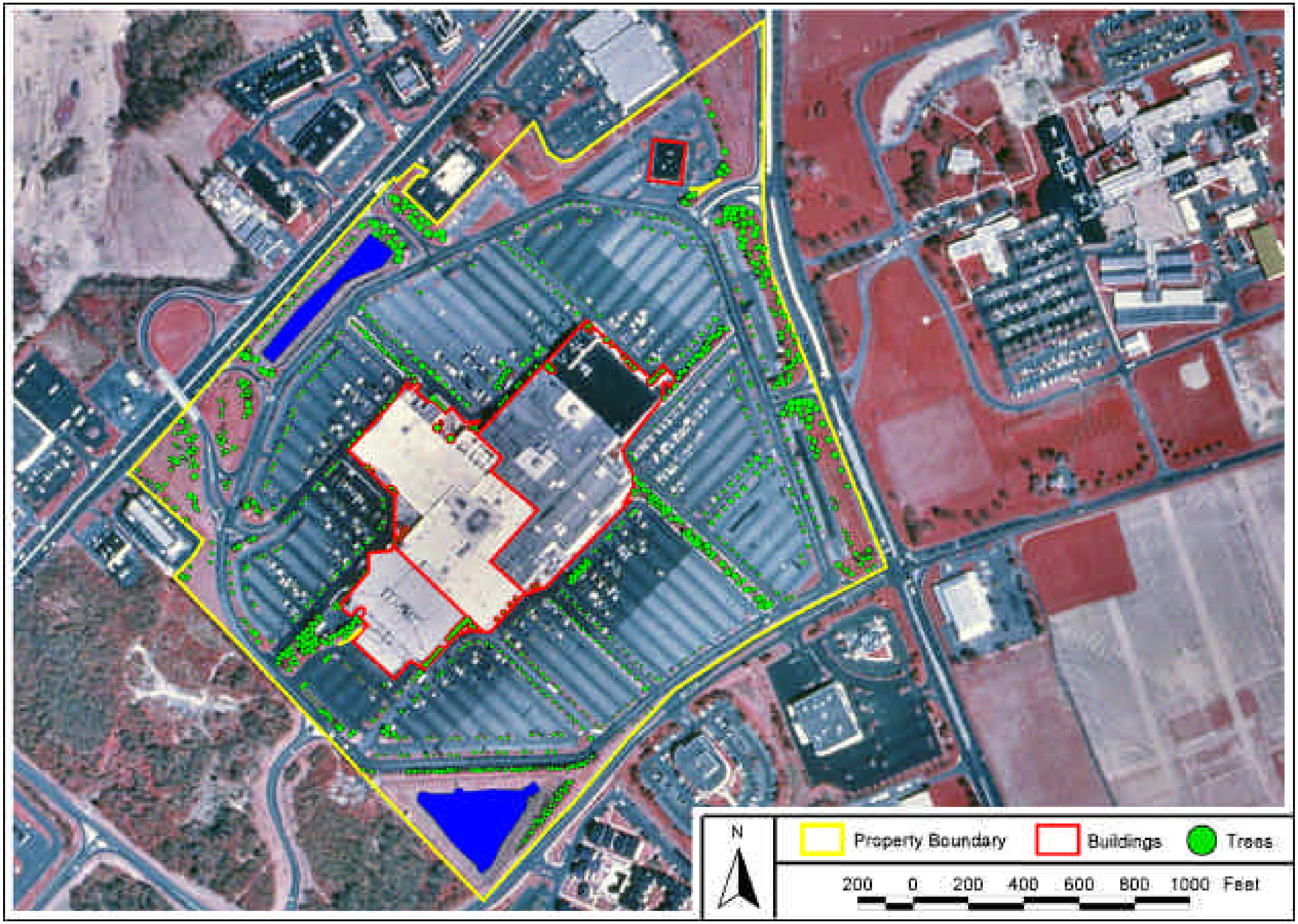
- At Quaker Bridge Mall, safety issues were of utmost importance to the management. Main changes to the landscape were dictated by customer safety concerns. The removal of large trees and overgrown shrubs improved lines of sight and, in the opinion of the manager, achieved the objective of increasing personal security at the mall. According to Mr. Ferreira, customer traffic through the mall has increased and vacancy rates have decreased since the start of the upgrade and the changes in landscaping. Security incidents in the mall fell 10% in 1997 over 1996.
- Competitor activity, the landscape plan and the available budget were all factors that affected the landscaping activities at Quaker Bridge Mall. The management at the mall carried out an informal cost benefit analysis that allowed them to identify the most heavily trafficked entrances and plan to landscape accordingly. Planting was carried out where maintenance costs were lower and where plants would not be damaged.
- The reason investment was made in exterior landscape elements at Quaker Bridge Mall was because customers liked to see color. It was felt important to break up the 64-acre hard surface of the parking lot with some color.
- Competitor activity in nearby malls was taken into consideration when planning landscape changes. The management at Quaker Bridge Mall considered that the landscaping in and around the mall compared favorably with other commercial sites in the area.
- Flowers and plants were considered to be the best use of landscape dollars. They were high impact because they added color and could be changed with the season. Tree maintenance was considered the least value for the money, because customers would only notice if it was not done.

**To Commercial Tenants:**

- According to the management at Quaker Bridge, renters did not notice the investment in landscape at the mall.
- Management felt that better landscaping over the last five years had been a factor in decreasing vacancy rates.
- Renters do not use the improved landscape in their marketing material.

**To Customers:**

- Management felt that customers did notice the improved landscape.
- Customers especially noticed the better sight lines and the more open nature of the landscape thanks to the removal of the overgrown trees.
- Increased customer traffic through the mall was due, in part to the enhanced feeling of security resulting from the elimination of unsafe landscape elements.




*Map 4.01: Quaker Bridge Mall 1999 (Existing trees)*

## Quantified Value of the Urban Forest

According to the UFORE analysis the economic value from the pollutant removal by the 1,177 trees at Quaker Bridge Mall was $1,382 for 1999. CITYgreen's analysis for 1999 was similar with a calculated value of $1,441 for the removal of 600 pounds of air pollutants from the region. The trees also stored approximately 226 tons of carbon, which was unvalued. (UFORE and CITYgreen's carbon storage varied by 105 tons and the sequestration rates varied by 3 tons per year.)

If the trees present in 1999 had been on the site prior to the construction of the on-site stormwater management system; the amount of stormwater runoff would have been reduced by almost 53,000 cubic feet. Thereby it provided a one-time construction cost reduction of approximately $33,000 by constructing a smaller on-site stormwater management system. According to UFORE calculations the species of trees on site would also emit 270 pounds (1.3 tons) of volatile organic compounds (VOCs) annually. This would reduce the annual benefits provided by the trees. The UFORE model also provided the intrinsic value of the 1999 landscape trees to be $1,380,474 based on the size, health and species of trees on the 105-acre commercial site. (figure 4.03)

## Projected Value of the Urban Forest

Using CITYgreen growth projections, the existing trees were grown-out for ten and twenty year periods. By the year 2009 the 6.2-acre canopy increased to 12.5 acres. The annual economic benefits for air pollution removal provided by the on-site trees in 2009 would be $2,928 – a 103% increase in annual benefits as compared to 1999. By 2019 the on-site tree canopy would expand to cover 15.5 acres with the value of benefits increasing to $3,640 per year. Using 1999 dollar-values and a linear progression for the twenty-year span from 1999 to 2019, the Quaker Bridge Mall trees provided economic benefits of $54,683 to the region by removing air pollutants over two decades.

Additionally the amount of carbon stored in the on-site trees was valuable, but no dollar value was assigned for it. The amount of carbon stored on-site increased 203% in the twenty years from 1999 to 2019 – from 227 tons to 686 tons. The presence of trees on-site also provided a valuable service of reducing the amount of on-site stormwater runoff. In 1999 trees reduced the amount of stormwater runoff on site by 52,957 cubic feet. By the year 2019 the matured trees reduced the amount of annual on-site stormwater runoff by 133,323 cubic feet. In twenty years stormwater runoff discharged from the site into neighboring water bodies was reduced by 152%, thereby improving the quality of water in the regional watershed. (figure 4.04)

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
Quaker Bridge Mall Tree Canopy: 6.2 acres

| Environmental Benefit | UFORE Removal by Trees | | UFORE Value | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | – – | | NC | 52,957 | CF | $33,221 |
| Carbon Storage | 121.38 | tons | – | 226.75 | tons | – |
| Carbon Sequestration | 5.91 | tons/yr | – | 2.97 | tons/yr | – |
| Ozone Removal | 212.55 | lbs. | $652 | 209.64 | lbs. | $643 |
| SO2 Removal | 46.42 | lbs. | $35 | 65.38 | lbs. | $49 |
| NO2 Removal | 93.85 | lbs. | $288 | 119.97 | lbs. | $368 |
| PM10 Removal | 194.43 | lbs. | $398 | 181.24 | lbs. | $371 |
| CO Removal | 23.65 | lbs. | $10.29 | 24.19 | lbs. | $10.52 |
| | **VALUE per year** | | $1,382 | **VALUE per year** | | $1,441 |
| | | | | **with stormwater** | | $34,662 |

*figure 4.03*

**Quantifiable Benefits of Quaker Bridge Mall Trees Projected from 1999 Site Data**

| Environmental Benefit | 10-YEAR GROW-OUT: 2009 (Tree Canopy: 12.46 acres) Removal by Trees | | Value | 20-YEAR GROW-OUT: 2019 (Tree Canopy: 15.52 acres) Removal by Trees | | Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | 107,948 | CF | NC | 133,323 | CF | NC |
| Carbon Storage | 516.61 | tons | – | 685.84 | tons | – |
| Carbon Sequestration | 2.93 | tons/yr | – | 1.20 | tons/yr | – |
| Ozone Removal | 426.00 | lbs. | $1,306 | 529.45 | lbs. | $1,623 |
| SO2 Removal | 132.35 | lbs. | $99 | 164.50 | lbs. | $123 |
| NO2 Removal | 244.13 | lbs. | $748 | 303.52 | lbs. | $930 |
| PM10 Removal | 368.02 | lbs. | $753 | 457.48 | lbs. | $936 |
| CO Removal | 49.05 | lbs. | $21.33 | 60.80 | lbs. | $26.44 |
| | **VALUE per year** | | $2,928 | **VALUE per year** | | $3,640 |

*figure 4.04*


# MARKET FAIR

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Mr. Matthew K. Klutznick, General Manager
Daniel Dobromilsky, CLA, West Windsor Township Landscape Architect
**Address:** 3535 US Route 1, Princeton, NJ 08540
**Location:** The mall was situated in West Windsor Township on the southbound side of US Route 1, 3 miles north of I-95/I-295 and 18.5 miles south of Exit 9 of the New Jersey Turnpike. The mall was also accessible from Meadow Drive.

## General Site Description

Market Fair is a 240,000 square foot 'Lifestyle Mall'offering a mix of upscale lifestyle stores like Smith & Hawken (garden store), Williams Sonoma (kitchen store), Restoration Hardware (designer furniture store) and Pottery Barn (contemporary home décor). The mall was opened in 1987 as planned urban development. At that time it had the traditional mix of large department stores as anchors and smaller specialist apparel stores. It was designed like a traditional mall with a small number of entrances and all access to stores from the interior. Trees were planted around the building to disguise an unattractive façade and the many loading bays that were visible from the nearby Route 1 traffic.

In 1996 the current management took over and replaced the traditional mix with the stores listed above as well as a large Barnes & Noble bookstore, a multi-screen movie theatre and a high-end food court, as well as a number of specialty gift and apparel stores. Management also changed the traditional structure and created a more highly visible store frontage to take advantage of the 74,000 cars that passed by daily on US Route 1.

The new design resulted in many trees being removed but they were replanted according to strict township ordinances. The trees were moved from the straight-line plantings of the prior design and planted in more 'organic' shapes near common entrances and in areas with exterior seating around the periphery of the mall. At the time of the interview vacancy rates were down and the management had plans for an upscale restaurant in the mall's vacant space. (figure 4.05)

| Market Fair Site Facts | | |
|---|---|---|
| Area of Site | 34.01 | acres |
| Area of Site | 0.05 | square miles |
| Parking spaces | | spaces |
| Impervious Surface | 75.5% | |
| Building Area | 6.32 | acres |
| Paved Area | 19.37 | acres |
| Pervious Surface | 24.5% | |
| Water Surface | 0.00 | acres |
| Tree Canopy Area* | 4.47 | acres |
| Forest Patch Canopy Area** | 0.43 | acres |
| Sampled Trees | 767 | trees |
| Estimated for Non-Sampled Areas | 97 | trees |
| Total Trees ( including forest patch (FP) areas) | 864 | trees |
| Tree Species (including FP) | 19 | species |
| Tree Density | 31.20 | trees/acre |
| Average Tree Ht (including FP) | 24.0 | feet in Ht |
| Average Tree DBH (including forest patches) | 7.3 | inch DBH |
| Average Tree Health*** (including forest patches) | 3.9 | rating |
| Intrinsic Value of On-Site Trees | $ 944,534 | |
| Tree Planting Cost (estimated by management) | not | provided |
| Landscape Maintenance Cost (est. by mgmt.) | not | provided |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site was developed.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.05*

### Urban Forest and Landscape Amenities Description

- The parking lot and other external areas at Market Fair had 864 trees divided among 19 species. These trees were planted in curbed, raised islands in the parking lot along the exterior of the building and in clusters near common entrances and 'dead' zones on exterior footpaths.
- The landscaping also included large colorful planted areas with seasonal shrubs and flowers. These areas were changed 14 times per year.
- The original landscape was dictated in large part by ordinances set down by the township of West Windsor.
- Changes to this landscape were within these ordinances, which stated that no tree could be removed without a replacement tree being planted somewhere else on site. (figure 4.06)

### Perceived Value of the Urban Forest and Landscape Amenities

**To Mall Manager:**

- Mr. Klutznick was aware that an upscale mall should project an upscale image and used landscaping as one way to do this. The management at the mall was aware of landscaping activities elsewhere in the region but also across the country and internationally.
- Ordinances and budgets were the two main factors determining the elements of the exterior landscape.
- Competitor activity and customer expectation were the two main factors that determined the level of investment in landscape.
- The largest constraint on landscaping activity was cost.
- Landscaping was used as a promotional tool when marketing the mall to prospective tenants and customers.
- The best value for money was considered to be the multiple flower rotations. These rotations were highly visible.
- The least value for money was the grass in the parking lot islands. This was difficult to maintain especially during recent drought-stricken summers. The islands were difficult to mow and water.

**To Commercial Tenants:**

- Because landscaping costs were passed to the tenant, the cost could only reach a certain level before the balance between cost and attractiveness to the tenant was skewed.

| Market Fair Tree Statistics | | | |
|---|---|---|---|
| **Scientific name** | **Common Name** | **Count** | **Percent** |
| Acer rubrum | Maple, Red | 254 | 29.4% |
| Cornus florida | Dogwood, Flowering | 2 | 0.2% |
| Crataegus phaenopyrum | Hawthorn, Washington | 49 | 5.7% |
| Fraxinus pennsylvanica | Ash, Green | 1 | 0.1% |
| Ilex opaca | Holly, American | 2 | 0.2% |
| Juniperus virginiana | Cedar, Red | 3 | 0.3% |
| Liquidambar styraciflua | Sweetgum | 92 | 10.6% |
| Magnolia x soulangiana | Magnolia, Saucer | 23 | 2.7% |
| Malus spp. | Crabapple | 50 | 5.8% |
| Picea abies | Spruce, Norway | 19 | 2.2% |
| Pinus strobus | Pine, Eastern White | 20 | 2.3% |
| Pinus thunbergiana | Pine, Japanese Black | 43 | 5.0% |
| Platanus x acerifolia | Planetree, London | 112 | 13.0% |
| Prunus serrulata | Cherry, Japanese | 18 | 2.1% |
| Pyrus calleryana | Pear, Callery | 74 | 8.6% |
| Quercus palustris | Oak, Pin | 37 | 4.3% |
| Salix alba 'Tristis' | Willow, Weeping | 4 | 0.5% |
| Tilia cordata | Linden, Littleleaf | 53 | 6.1% |
| Tsuga canadensis | Hemlock, Eastern | 8 | 0.9% |
| | **Total Tree Count** | **864** | **100.0%** |

*figure 4.06*

- Management felt that tenants did not appreciate the cost and maintenance involved in both exterior and interior landscaping efforts. The management at Market Fair would like to see the tenants introducing some flowers or plants into their own stores. This would enhance the appeal of the surroundings.

**To Customers:**

- Management felt that good landscaping helped to create an environment conducive to lingering and to selling more merchandise.
- They felt poor or no landscaping would hasten customers from the mall.
- Acknowledging the upscale nature of the regional demographics led the mall management to package the mall to appeal to an affluent group. (Within a 5-mile radius of the center, the Average Household Income was more that $94,500. The median age of these households was 35.) Landscaping was considered essential to this appeal. The management at the mall attempted to provide a level of landscaping that their target group would expect and would be used to from elsewhere.


*Map 4.02: Market Fair 1999 (Existing trees)*

### Quantified Value of the Urban Forest

In 1999 the canopy of the 864 trees covered 13% of the 4.5-acre Market Fair site. According to UFORE calculations the trees provided a regional economic benefit of approximately $1,060 by removing 436 pounds of air pollutants from the area. The tree count included the natural woodland buffer in the front of the site that remained after the construction of the mall. (The CITYgreen calculations indicated a similar beneficial value to the region – $1,048.) In 1999 the trees also stored about 150 tons of carbon at a rate of 3 tons per year. UFORE and CITYgreen's carbon calculations were once again quite different with CITYgreen indicating 133% more carbon stored.

If the trees present in 1999 were on-site prior to construction of any on-site stormwater management systems, the amount of calculated runoff would be reduced by 37,145 cubic feet, thereby providing a one-time construction cost reduction of almost $28,000. UFORE identified a negative effect of VOC emissions from the onsite trees of 283 pounds (1.4 tons) per year based on the species. If values were assigned to the emissions, it would reduce the total benefits provided by the trees. The on-site trees at Market Fair were valued by UFORE at $944,534. (figure 4.07)

### Projected Value of the Urban Forest

The growth of the existing trees were projected ten and twenty years into the future with the value of their benefits projected for 2009 and 2019. By the year 2009 the on-site tree canopy increased to cover 8.3 acres of the site and the trees removed $1,953 worth of pollutants from the region – an increase of 86% per year as compared to 1999. In 2019 if no additional trees were removed or planted, CITYgreen growth projections indicated that the urban forest canopy would cover 10.25 acres and would remove 1,002 pounds of pollutants from the region at an estimated annual regional benefit of $2,406. This was a 130% increase in the annual value as compared with 1999.

A linear progression calculated the twenty-year value of the 864 trees in the Market Fair community forest. From 1999 to 2019 they provided $36,800 (using 1999 dollar-values) of benefits to the region from the removal of 15,327 pounds of air pollutants. In addition to air pollution removal the trees on site provided additional benefits where economic values were not assigned – carbon storage and the reduction of stormwater runoff. The amount of carbon stored on site increased 137% from 149 tons in 1999 to 354 tons in 2019. In the same twenty years the annual stormwater runoff was reduced by 131% as compared to the amount of 1999 runoff reduction. In 2019 the maturing on-site urban forest removed 85,614 cubic feet of stormwater runoff – an important benefit to the region's water quality. (figure 4.08)

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
Market Fair Tree Canopy: 4.5 acres

| Environmental Benefit | UFORE Removal by Trees | | UFORE Value | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | – | – | NC | 37,145 | CF | $27,926 |
| Carbon Storage | 63.98 | tons | – | 149.18 | tons | – |
| Carbon Sequestration | 3.96 | tons/yr | – | 2.97 | tons/yr | – |
| Ozone Removal | 164.86 | lbs. | $505 | 152.50 | lbs. | $467 |
| SO2 Removal | 34.41 | lbs. | $26 | 47.38 | lbs. | $36 |
| NO2 Removal | 73.09 | lbs. | $224 | 87.51 | lbs. | $268 |
| PM10 Removal | 145.02 | lbs. | $297 | 131.69 | lbs. | $270 |
| CO Removal | 17.74 | lbs. | $7.72 | 17.54 | lbs. | $7.63 |
| | **VALUE per year** | | $1,060 | **VALUE per year** | | $1,048 |
| | | | | **with stormwater** | | $28,975 |

*figure4.07*

**Quantifiable Benefits of Market Fair's Trees Projected from 1999 Site Data**

| Environmental Benefit | 10-YEAR GROW-OUT: 2009 Tree Canopy: 8.31 acres Removal by Trees | | Value | 20-YEAR GROW-OUT: 2019 Tree Canopy: 10.25 acres Removal by Trees | | Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | 69,321 | CF | NC | 85,614 | CF | NC |
| Carbon Storage | 273.70 | tons | – | 353.60 | tons | – |
| Carbon Sequestration | 5.78 | tons/yr | – | 6.22 | tons/yr | – |
| Ozone Removal | 284.13 | lbs. | $871 | 349.95 | lbs. | $1,073 |
| SO2 Removal | 88.23 | lbs. | $66 | 108.74 | lbs. | $82 |
| NO2 Removal | 162.98 | lbs. | $500 | 200.72 | lbs. | $615 |
| PM10 Removal | 245.53 | lbs. | $503 | 302.43 | lbs. | $619 |
| CO Removal | 32.55 | lbs. | $14.16 | 40.12 | lbs. | $17.45 |
| | **VALUE per year** | | $1,953 | **VALUE per year** | | $2,406 |

*figure4.08*

*Entrance to Market Fair from local roadway.*

## Shopping Mall Case Study Findings

Based on the quantity, species, size and health of the trees and forestland on the two mall study sites researchers projected the 2,041 trees would remove 38,100 pounds of air pollutants over twenty years at a value of $91,500 to the region. Security concerns and maintaining a competitive level were the driving factors in the landscape renovations at Quaker Bridge Mall. On the other hand, Market Fair's renovations were the result of changes in the mall's layout and were planned to ensure the shopper's perception of a high-end lifestyle mall.

When minimum standards for the landscaping new commercial developments were raised, the landscapes of older developments were well below the new standards. As the larger and older of the two malls in the study area, Quaker Bridge Mall was a good example of a site manager understanding the need to upgrade their landscape to compete with the newer, greener retail shopping centers in the region. This investment in the green infrastructure was determined without ordinances requiring an upgrade.

Quaker Bridge Mall was established in an era when the landscaping was often one of the first things cut in the budgets of commercial, as well as residential, developments. It was designed when seas of asphalt with few parking lot trees surrounded centralized shopping malls. Only 6% of this 105-acre site had a tree canopy cover and 78% of the site was impervious surface. When the managers of older malls saw the loss of their tenants and their customer base, they looked at their competition and determined what changes would make them more competitive. Often this included upgrading the landscape.

Most landscaping ordinances do not address landscaping or planting during renovations of commercial sites. Any improvements therefore were based upon the values that the mall management and its consulting professionals placed on the landscape in making them more competitive. Fortunately Quaker Bridge's current management saw that upgrading the landscape was important to competing with others in the region for customers and tenants.

The areas adjacent to the mall's exterior façade had few landscaped areas with most of the areas being small or narrow. Many of these landscaped spaces had become overgrown. Quaker Bridge addressed these aesthetic and safety issues during their renovations to compete with nearby retail centers. They removed or pruned overgrown plantings and raised the quality of the plantings near mall entrances that had areas large enough for planting.

The management said that planting additional trees within the massive 64-acre parking lot was not a priority at this time, however they were removing the dead and dying trees throughout it. And although it was not mandated that they replace them, they were – perhaps because they understood the value of these trees within the sea of asphalt surrounding the mall. Not only did the trees help shoppers identify traffic patterns, but the mature trees in the parking lots provided shaded parking options to employees and customers. On any hot, sunny day, researchers observed people opting to park in the shade of a tree and walk the extra distance to the nearest mall entrance.

The 1,177 trees on the Quaker Bridge Mall site provided benefits to the region by improving the air quality and reducing the amount of stormwater runoff that was discharged into the region's waterways. With the management finalizing their landscape upgrades, the environmental benefits and their calculated value to the region will increase.

As the most recently developed of the two malls in the study area, Market Fair was a good example of what was designed when developers, mall management and township officials valued trees and other landscape elements in a site's urban forest.

Strong ordinances that required the preservation and care of existing woodlands or trees during commercial development; that required buffer plantings between properties or different types of zoning; that required sufficient plantings within large areas of paving, particularly parking lots; or that required a property buffer characteristic of the existing area's cultural landscape experience along surrounding roadways did not deter sound commercial development.

Some municipal officials and their professionals thought these types of ordinances placed unnecessary encumbrances on the developer of a site and hindered commercial development in their municipality. Instead well informed management and developers, such as those at Market Fair, recognized the value of a quality exterior landscape in competing with other malls for retail tenants, maintaining low vacancy rates and attracting customers. They contended that shoppers' first views of the mall, as well as the experiences shoppers encountered while driving through the mall, parking and walking to the entrances influenced shoppers' expectations of the types of stores inside. The outside experiences of shoppers were imprinted in their memories, along with their inside shopping experiences. These experiences influenced if they would return to the mall or how often they would return.

Quality ordinances that protected existing woodlands and promoted the creation of an urban forest canopy through landscaping did not prevent quality commercial development from entering West Windsor; nor did they destroy the experience of those who shopped at the mall or traveled through the area along US Route 1. The high standards set by the strong ordinances in West Windsor, including their 1:1 tree replacement policy, did not prevent or deter commercial development; rather it encouraged environmentally sound development in the fast-growing region. And it attracted developers who respected the region, saw the advantages of developing in the region and wanted to contribute to improving the aesthetics and the quality of life in the community. Developers who could not or would not abide by standards established to improve a community moved to areas where the decision-makers had not made the connection between higher landscape standards in residential and commercial developments and a better quality of life for the people living in their area.

The view of Market Fair by the hundreds of thousands of people who passed by while traveling up and down heavily-trafficked US Route 1 was aesthetically pleasing in all seasons and invited people to shop, as well as stay in the region. Because of the high standards established for landscaping of commercial sites in this highly traveled and fast-developing region, valuable regional benefits could be maintained and commercial developments could be successful in attracting customers and merchants.

The managers did not specify which landscape elements represented the least value for the money, however they agreed that lawn areas wasted a lot of money for maintenance. Trees were also noted as being a drain on maintenance budgets with the high costs for pruning branches, removing trees and cleaning up fallen leaves. However trees were also recognized as being good investments that visually broke up the huge seas of asphalt parking lots, directed traffic flow and cooled parked cars and the pedestrians on hot days. These contradicting statements reflect the manner in which managers often view trees and the landscape – heavy consumers of time and money, but necessary investments that encourage a commercial success.

## Strip Shopping Center Case Studies

The strip shopping centers selected for as case studies had rows of attached stores with on-site parking in front of the stores and access to the stores from the parking areas. Two of the older shopping centers were selected because of the low amount of green infrastructure on-site – Lawrence Center (Lawrence) and Brunswick Shopping Center (North Brunswick). Both of these sites also underwent landscaping and façade improvements during the time of the research study. One site was selected as a case study because it had the highest amount of tree canopy, including the natural woodlands that remained after development – South Brunswick Square Mall (South Brunswick).

# BRUNSWICK SHOPPING CENTER

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** unable to get an interview appointment
**Address:** Georges and Milltown Road, North Brunswick, NJ 08902
**Location:** The shopping center was on the southbound side of US Route 1 in North Brunswick Township approximately 3 miles south of Exit 9 of the New Jersey Turnpike and 18.5 miles north of I-95/I-295. It was accessible from Georges Road and Milltown Road.

## General Site Description

Brunswick Shopping Center was a 'Neighborhood Shopping Center' with approximately 200,000 square feet of shopping area on a 23-acre site. It was configured as a straight-line strip of stores with a slight bend at one end. Its primary trade was drawn from an area approximately 3 miles from the site. At one time Caldor, a discount department store, was the anchor store for the shopping center. The shopping center also provided general merchandise and convenience items. The anchor was supported by a McDonald's restaurant and stores offering drugs, snacks, cards, videos, laundry services, liquor, hair styling, discount clothing and sundry items. There were also offices whose entrances were located on the other side of the shopping center.

In order to compete and invite a new anchor store into the shopping center, the site was upgraded a few years prior to the study. They added planting islands to the sea of asphalt that surrounded the building and planted and improved the entranceways. Prior to the upgrade there were only twenty trees on site at a density of approximately one tree per acre.

*Landscaping was located at entrances to shopping center.*

| Brunswick Shopping Center Site Facts | |
|---|---|
| Area of Site | 22.82 acres |
| Area of Site | 0.04 square miles |
| Impervious Surface | 92.4% |
| Building Area | 5.18 acres |
| Paved Area | 15.90 acres |
| Pervious Surface | 7.6% |
| Water Surface | 0.00 acres |
| Tree Canopy Area* | 0.16 acres |
| Forest Patch Canopy Area** | 0.00 acres |
| Trees (not including forest patch areas) | 99 trees |
| Tree Species (without forest patches-FP) | 9 species |
| Tree Density | 5.61 trees/acre |
| Average Tree Ht (without FP) | 12.0 feet in Ht |
| Average Tree DBH (without FP) | 3.1 inch DBH |
| Average Tree Health*** (without FP) | 3.4 rating |
| Intrinsic Value of On-Site Trees | $23,653 |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure4.09*

In 2000 another upgrade was planned for the site that included improving the shopping center's façade and expanding the floor coverage for a new anchor store – A & P, a supermarket. Researchers were unable to get any information as to the amount of green infrastructure that would be added or removed from the site during the next anticipated upgrade. (figure 4.09)

## Urban Forest and Landscape Amenities Description

- Prior to the site upgrade Brunswick Shopping Center had only twenty trees on site at a density of 1 tree per acre – the least amount of green infrastructure of all the sites studied along the US Route 1 corridor.

- After the upgrade the site had 99 trees of nine species at a density of 5.6 tree per acre, which created 0.16 acres of tree canopy – less than 1% coverage of the 22.8-acre site.

- The 500% increase in trees did not create a large tree canopy coverage because the recently planted trees were still small with an average height of 12-feet and an average trunk diameter of 3-inches.

- Landscaping efforts were concentrated at the two main entrances to the site. These included shrubs, ornamental grasses, ground covers and perennials. The majority of trees were planted along the outer edges of the parking lot to define traffic flow, rather than near the buildings or in the parking lot aisles.

- Only the McDonald's restaurant had plantings adjacent to the building. It also had planting islands of shrubs and ornamental grasses nearby.

- The larger mature trees were located at the site's perimeter along the entrance ramp from Millstone Road onto US Route 1 southbound and along US Route 1.

- 62% of the 99 trees were a mixture of eight species that ranged from 1% to 16% of one species. Crabapples made up the remaining 38%, which was a high percentage of one type of tree. Unless the selected crabapple cultivars were a type with high resistance to insects and diseases, the infestation of one tree could infect or cause the loss of all the others. (figure 4.10)

| Brunswick Shopping Center Tree Statistics | | | |
|---|---|---|---|
| **Scientific name** | **Common Name** | **Count** | **Percent** |
| Acer platanoides | Maple, Norway | 10 | 10.1% |
| Acer rubrum | Maple, Red | 7 | 7.1% |
| Ailanthus altissima | Tree of Heaven | 1 | 1.0% |
| Celtis occidentalis | Hackberry, Common | 1 | 1.0% |
| Ilex opaca | Holly, American | 16 | 16.2% |
| Malus spp. | Crabapple | 38 | 38.4% |
| Prunus serrulata | Cherry, Japanese | 14 | 14.1% |
| Quercus acutissima | Oak, Sawtooth | 11 | 11.1% |
| Quercus palustris | Oak, Pin | 1 | 1.0% |
| | **Total Tree Count** | **99** | **100.0%** |

*figure 4.10*

### Perceived Value of the Urban Forest and Landscape Amenities

Researchers were unable to interview any managers of the shopping center or any of the tenants to obtain their perception of the value of the green infrastructure on site. The only indication that management or owners understood the value of landscaping was the upgraded efforts that had taken place after the loss of Caldor, the shopping center's anchor store. Additionally the plans for future upgrading indicate an understanding of the benefits and values of trees and other vegetation on-site.

### Quantified Value of the Urban Forest

Prior to the most recent site upgrades the site had a density of one tree per acre. The 0.09-acre canopy of the twenty mature trees on the site provided a regional value of $21 per year from air pollution removal. (figure 4.11)

With a 400% increase in the quantity of trees on site the pollution removal value increased by 81% using CITYgreen results. However the 99 newly planted trees were small and with time provided increasing environmental benefits to the area. For 1999 UFORE and CITYgreen estimated that values for removing about 15 pounds of air pollutants was $34 and $37 respectively. Once again the calculated amount of carbon sequestered in 1999 varied immensely between UFORE (2,600 pounds) and CITYgreen (10,160 pounds). The trees also emitted 4 pounds of VOCs, reducing the total benefits to the region. UFORE estimated the intrinsic value of the existing trees on the 23-acre site to be $23,653.

If the trees present in 1999 were planted prior to the construction of the on-site stormwater management system, the amount of calculated stormwater runoff would be reduced by 1,549 cubic feet, thereby providing a one-time cost savings of approximately $5,900 at the time of construction. (figure 4.12)

**Quantifiable Benefits of Trees Prior to Landscape Upgrade**

Brunswick Shopping Center Tree Canopy: 0.09 acres

| Environmental Benefit | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|
| Stormwater Reduction | 870 | CF | $4,445 |
| Carbon Storage | 2.87 | tons | – |
| Carbon Sequestration | 0.07 | tons/yr | – |
| Ozone Removal | 3.00 | lbs. | $9 |
| SO2 Removal | 0.90 | lbs. | $1 |
| NO2 Removal | 1.70 | lbs. | $5 |
| PM10 Removal | 2.60 | lbs. | $5 |
| CO Removal | 0.30 | lbs. | $0.13 |
| | **VALUE per year** | | $21 |

*figure 4.11*

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**

Brunswick Shopping Center Tree Canopy: 0.16 acres

| Environmental Benefit | UFORE Removal by Trees | | UFORE Value | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | – – | | NC | 1,549 | CF | $5,895 |
| Carbon Storage | 1.30 | tons | – | 5.08 | tons | – |
| Carbon Sequestration | 0.14 | tons/yr | – | 0.11 | tons/yr | – |
| Ozone Removal | 5.51 | lbs. | $17 | 5.40 | lbs. | $17 |
| SO2 Removal | 1.16 | lbs. | $1 | 1.70 | lbs. | $1 |
| NO2 Removal | 2.36 | lbs. | $7 | 3.10 | lbs. | $10 |
| PM10 Removal | 4.45 | lbs. | $9 | 4.70 | lbs. | $10 |
| CO Removal | 0.65 | lbs. | $0.28 | 0.60 | lbs. | $0.26 |
| | **VALUE per year** | | $34 | **VALUE per year** | | $37 |
| | | | | **with stormwater** | | $5,932 |

*figure 4.12*


*Map 4.03: Brunswick Shopping Center 1999 (Existing trees)*

## Projected Value of the Urban Forest

Using CITYgreen growth projections, the trees on the Brunswick Shopping Center in 1999 were grown-out for ten and twenty year periods. In each of the ten-year periods the tree canopy expanded by about 43.5%. The trees on site provided a $76 annual air pollution removal benefit to the area in 2019 – a 106% increase from 1999. Using a linear progression for the twenty years from 1999 to 2019 the on-site trees removed 458 pounds of pollutants and provided approximately $1,100 worth of benefits (at a 1999 monetary value) to the region.

In addition to those benefits that were quantified and valued, the site provided benefits that had no economic values assigned to them as yet. The trees on site increased their carbon storage capacity by 107% from 5 tons to 10.5 tons in two decades. Additionally the presence and growth of the trees reduced the amount of stormwater runoff discharged into our streams. The annual amount of runoff discharge was 230% more in 2019 then it was in 1999. In two decades the 99 trees reduced on-site stormwater runoff by 68,660 cubic feet. As the on-site trees matured so did their measurable and unmeasurable values. (figure 4.13)

**Quantifiable Benefits of Brunswick Shopping Ctr's Trees Projected from 1999**

| **Environmental Benefit** | **10-YEAR GROW-OUT: 2009** Tree Canopy: 0.23 acres | | | **20-YEAR GROW-OUT: 2019** Tree Canopy: 0.33 acres | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 3,528 | CF | NC | 5,127 | CF | NC |
| Carbon Storage | 7.29 | tons | – | 10.53 | tons | – |
| Carbon Sequestration | 0.16 | tons/yr | – | 0.24 | tons/yr | – |
| Ozone Removal | 7.70 | lbs. | $24 | 11.10 | lbs. | $34 |
| SO2 Removal | 2.40 | lbs. | $2 | 3.50 | lbs. | $3 |
| NO2 Removal | 4.40 | lbs. | $13 | 6.40 | lbs. | $20 |
| PM10 Removal | 6.70 | lbs. | $14 | 9.60 | lbs. | $20 |
| CO Removal | 0.90 | lbs. | $0.39 | 1.30 | lbs. | $0.57 |
| | **VALUE per year** | | $53 | **VALUE per year** | | $76 |

*figure 4.13*


*Map 4.04: Brunswick Shopping Center 2019 (Existing trees with projected 20-year grow-out)*

| Lawrence Shopping Center Site Facts | |
|---|---|
| Area of Site | 48.39 acres |
| Area of Site | 0.08 square miles |
| Impervious Surface | 69.6% |
| Building Area | 8.73 acres |
| Paved Area | 24.94 acres |
| Pervious Surface | 30.4% |
| Water Surface | 1.57 acres |
| Tree Canopy Area* | 0.74 acres |
| Forest Patch Canopy Area** | 3.14 acres |
| Trees (not including forest patch areas) | 272 trees |
| Tree Species (without forest patches-FP) | 17 species |
| Tree Density | 6.86 trees/acre |
| Average Tree Ht (without FP) | 19.0 feet in Ht |
| Average Tree DBH (without FP) | 5.7 inch DBH |
| Average Tree Health*** (without FP) | 3.0 rating |
| Intrinsic Value of On-Site Trees | $173,610 |
| Tree Planting Cost (estimated by management) | not provided |
| Landscape Maintenance Cost (est. by mgmt.) | not provided |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.14*

# L A W R E N C E   S H O P P I N G   C E N T E R

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Mr. Scott Plapinger, Owner and General Manager
**Address:** 2495 Brunswick Pike, Alternate Route 1 South, Lawrence, NJ 08648
**Location:** The mall was situated on the southbound lane of Alternate/Business Route 1 in Lawrence Township, approximately 2.4 miles south of I-95/I-295 and 24 miles south of Exit 9 of the New Jersey Turnpike. It was also accessible from Texas Avenue.

## G e n e r a l   D e s c r i p t i o n

Lawrence Shopping Center was a 'Community Center Shopping Center' with 375,000 square feet of retail space configured as a straight line/slight L-shape. Forty retailers rented space. The two anchor stores were the Burlington Coat factory, a discount apparel store and Acme, a supermarket. The remaining stores ranged from the large office supply chain store, Staples to smaller chain and independent specialty shops like Alphabet Soup (an independent bookstore for children), Kay-Bee Toys and USA Baby. Toy stores, electronics stores, drugstore, card store, jeweler, discount clothing and shoe stores, laundries, pet store, home improvement/furnishing stores, bank, photography store and snacks were also provided by the shopping center retailers.

The site also contained retailers in buildings opposite the shopping center that included a bank, furniture store, car repair store, restaurants and a stationery/paper store.

The mall was built in 1960 and underwent its first thorough renovation from 1997 to 1999. A group of citizens pushed for more landscaping and trees on-site. During the renovation the façade was improved, drainage problems in the parking lot were addressed and the parking lot received a complete landscaping, which included the addition of trees and other plantings in islands throughout the parking lot. Before the renovations the parking lot was a giant sea of asphalt, devoid of any trees or planting islands. As part of the renovation 165 trees were planted in islands throughout the parking lot and shrubs and flowers were added along the entrances to the site.

Following the renovation, vacancy rates were 8% (a decrease) and negotiations were underway for a new tenant for most of the 35,000 square feet that was vacant. (figure 4.14)

## Urban Forest and Landscape Amenities Description

- Prior to the 1999 landscape upgrade Lawrence Center had 107 trees, which were limited to entrances and buffers along the residential streets. These trees formed a 0.67-acre canopy.
- After the upgrade the site had 272 trees of 17 species, which created a 0.74-acre tree canopy over the 48-acre site.
- The new trees were planted in islands to direct traffic flow, indicate parking aisles and shade the parking lot.
- In addition to the landscaped trees, the site had more than 3 acres of forestland that had been undisturbed during the shopping center's development almost 40 years prior. This included trees along a waterway.
- The entrance off US Route 1 had a grove of mature cherry trees and flower beds that were rotated with seasonal changes.
- The lawn areas along US Route 1 required constant mowing.
- Although the shopping center did not have any plantings adjacent to its building façade, the buildings on-site that were opposite the center had more intimate and detailed plantings near their façades.
- With more than 170 new trees of 3-inch caliper, the average caliper (dbh) was almost 6-inches, which indicated that the older trees on-site were quite large.
- The health of the trees were rated at 3 out of 5 after a drought in 1999. As newly planted trees, most had a guarantee to be replanted if they did not survive.
- The density of landscaped trees on the site increased from just over 2.5 trees per acre to almost 7 trees per acre – a 150% increase in density. The impact was immediately noticeable by shoppers and tenants.
- Of the 272 landscape trees 32% of them were of fifteen different species with each species between 0.4% and 15.8%.
- The remaining 68% of the trees consisted of two species, ash at 41% and honeylocust at 27%. This is a high percentage of trees to be split by just two species. (figure 4.15)

**Lawrence Shopping Center Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Acer palmatum | Maple, Japanese | 1 | 0.4% |
| Acer platanoides | Maple, Norway | 7 | 2.6% |
| Acer rubrum | Maple, Red | 1 | 0.4% |
| Albizia julibrissin | Mimosa | 1 | 0.4% |
| Cornus florida | Dogwood, Flowering | 1 | 0.4% |
| Fraxinus pennsylvanica | Ash, Green | 111 | 40.8% |
| Gleditsia triacanthos var. inermis | Honeylocust, Thornless | 73 | 26.8% |
| Ilex opaca | Holly, American | 1 | 0.4% |
| Picea abies | Spruce, Norway | 43 | 15.8% |
| Pinus resinosa | Pine, Red | 1 | 0.4% |
| Prunus serrulata | Cherry, Japanese | 14 | 5.1% |
| Quercus palustris | Oak, Pin | 1 | 0.4% |
| Quercus prinus | Oak, Chesnut | 1 | 0.4% |
| Quercus rubra | Oak, Red | 11 | 4.0% |
| Robinia pseudoacacia | Locust, Black | 1 | 0.4% |
| Salix alba 'Tristis' | Willow, Weeping | 4 | 1.5% |
| | Total Tree Count | 272 | 100.0% |

*figure 4.15*

## Perceived Value of the Urban Forest and Landscape Amenities

**To Mall Manager:**

- The landscape upgrade was a part of the overall renovation plan carried out in early 1999. No cost benefit was done on the landscaping plan. Market knowledge and landscaping at other 'large shopping centers'in the region dictated the extent of landscape change. No budget was set. Plans were developed and then carried out.
- Mr. Plapinger felt that landscaping was something more notable by its absence than by its presence.
- Any economic impacts of the landscaping on lower utility costs or lower costs of doing business were not considered during the process. Aesthetics was the main concern with the landscaping plan.
- Mr. Plapinger felt that flowers provided the highest value for money because of their high visibility. He felt that shrubs and lawn went mostly unnoticed and provided the lowest value for money. The shrubs and lawn were replanted following a severe drought with watering restrictions.
- The newly installed landscape coupled with the new façade and the other upgrading in the shopping center resulted in a lower vacancy rate.

*Entrance with perennials and ornamental grasses.*

**To Commercial Tenants:**

- The tenants/merchants association promoted the whole new look of the shopping center including its new green elements in their advertising.

- A November 12, 1999 Princeton Packet newspaper article described the shopping center's renovations. One of the long-time tenants of the shopping center, Bob Vecere of Vecere Jewelers said "It's amazing what a new parking lot, trees and flowers can do." He said that he saw customers return to the shopping center, as well as a lot of new faces. Mr. Paul Carella of Paul's Step by Step shoe and apparel store cited the improved parking lot for improved business. "Just the parking alone, when that was renovated and the new lighting was put in, I think that helped extremely," he said.

"People are feeling better about coming here..."

**To Customers:**

- Mr. Plapinger felt that customers noticed the lack of landscaping rather than the presence of a good landscape concept.

- Mr. Vecere said that customers commented on the poor shape of the parking lot prior to its upgrade.

- Researchers were told that a citizen-designed photographic survey propelled the management of the shopping center to carry out the renovations.

- Traffic flow through the parking lot was safer.

**Quantifiable Benefits of Trees Prior to 1999 Landscape Upgrade**

Lawrence Center Tree Canopy: 0.67 acres without forested area (3.81 acres with forests)

| Environmental Benefit | CITYgreen w/o forest patches: Removal by Trees | CITYgreen w/o forest patches: Value | CITYgreen w/ forest patches: Removal by Trees | CITYgreen w/ forest patches: Value |
|---|---|---|---|---|
| Stormwater Reduction | 5,252 CF | $10,718 | 29,950 CF | $25,133 |
| Carbon Storage | 29.54 tons | – | 168.44 tons | – |
| Carbon Sequestration | 0.05 tons/yr | – | 0.29 tons/yr | – |
| Ozone Removal | 22.70 lbs. | $70 | 130.00 lbs. | $399 |
| SO2 Removal | 7.10 lbs. | $5 | 40.40 lbs. | $30 |
| NO2 Removal | 13.00 lbs. | $40 | 74.50 lbs. | $228 |
| PM10 Removal | 19.60 lbs. | $40 | 112.30 lbs. | $230 |
| CO Removal | 2.60 lbs. | $1 | 14.90 lbs. | $6 |
| | **VALUE per year** | $156 | **VALUE per year** | $894 |
| | **with stormwater** | $10,874 | **with stormwater** | $26,026 |

*figure 4.16*

## Quantified Value of the Urban Forest

Prior to the upgrade the forested land on site provided the majority of the benefits to the region. The value of the annual pollution removal benefits provided by the mature landscape trees on site prior to the 1999 upgrade was $156. By including the value of the 3-acres of forested land the annual value increased 473% to $894. The forest patches removed 307 tons of air pollution in one year, while the mature landscape trees removed only 65 tons. Additionally the forest patches sequestered 380% more carbon in one year (480 pounds versus 100 pounds) than the landscaped trees (pre-1999) and stored 370% more carbon than the landscaped trees (29.5 tons versus 138.9 tons).

The landscaped trees (pre-1999) reduced stormwater runoff by 5,252 cubic feet, whereas the forested areas reduced the stormwater runoff an additional 370% by capturing 24,698 cubic feet of runoff. Therefore, protecting existing forested land during development provided a bigger impact on environmental benefits to the area than the landscaped trees throughout the site. (figure 4.16)

UFORE and CITYgreen estimated the pollution removal value of the trees on site after the most recent upgrade to be of similar values; this being one of two case studies where UFORE's calculated value of $186 per year was higher than CITYgreen's value of $174. The 154% increase in landscape trees (107 trees to 272 trees) during the recent upgrade provided only a 19% increase in annual pollution removal value (from $156 to $186) for the removal of about 77 pounds of air pollutants. But that small increase in benefits was because the newly planted trees had a small canopy and after the drought, they were not in the best health. With tree canopy expansion and improved health the value of the trees will increase.

If the trees on site in 1999 had been planted prior to the construction of any stormwater management systems, stormwater runoff would have been reduced by 5,814 cubic feet. By including the 3-acre forest patch, the on-site stormwater runoff was reduced by another 24,698 cubic feet. Thereby a one-time cost saving of approximately $34,134 would have been provided at the time of the development of the on-site stormwater management system.

The trees also sequestered approximately 1,500 pounds of carbon, not including the forest patches. But according to UFORE the landscape trees emitted 83 pounds of VOCs, more than the pollutants that were removed by those same trees (77 pounds). However the on-site forested areas removed an additional 307 pounds of pollutants. The intrinsic value of the trees on site was $173,610, not including the forested areas. (figure 4.17 and 4.18)

**Lawrence Center Forest Patch Area (1999 Data)**

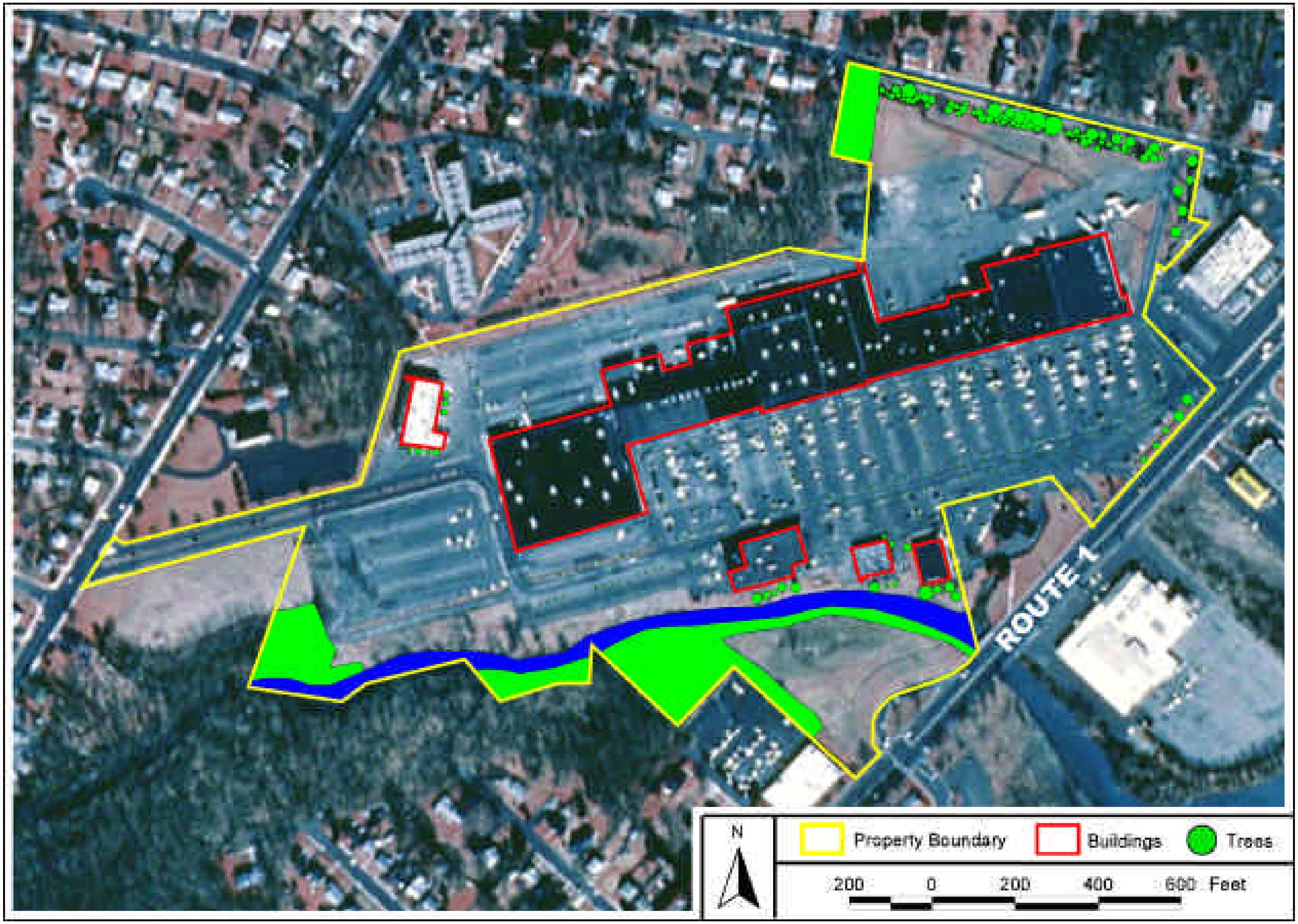
| Environmental Benefit | Tree Canopy: 3.14 acres | | |
|---|---|---|---|
| | Removal by Trees | | Value |
| Stormwater Reduction | 24,698 | CF | $22,869 |
| Carbon Storage | 138.90 | tons | – |
| Carbon Sequestration | 0.24 | tons/yr | – |
| Ozone Removal | 107.30 | lbs. | $329 |
| SO2 Removal | 33.30 | lbs. | $25 |
| NO2 Removal | 61.50 | lbs. | $189 |
| PM10 Removal | 92.70 | lbs. | $190 |
| CO Removal | 12.30 | lbs. | $5 |
| | **VALUE per year** | | $737 |
| | **with stormwater** | | $23,607 |

*figure 4.17*

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999 Upgrade)**
Lawrence Shopping Center Tree Canopy: 0.74 acres (without forest patches)

| Environmental Benefit | UFORE | | | CITYgreen | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | – | – | NC | 5,814 | CF | $11,265 |
| Carbon Storage | 30.59 | tons | – | 23.89 | tons | – |
| Carbon Sequestration | 0.96 | tons/yr | – | 0.54 | tons/yr | – |
| Ozone Removal | 28.92 | lbs. | $89 | 25.30 | lbs. | $78 |
| SO2 Removal | 6.31 | lbs. | $5 | 7.90 | lbs. | $6 |
| NO2 Removal | 12.61 | lbs. | $39 | 14.50 | lbs. | $44 |
| PM10 Removal | 25.54 | lbs. | $52 | 21.90 | lbs. | $45 |
| CO Removal | 3.33 | lbs. | $1.45 | 2.90 | lbs. | $1.26 |
| | **VALUE per year** | | $186 | **VALUE per year** | | $174 |
| | | | | **with stormwater** | | $11,439 |

*figure 4.18*




*Map 4.05: Lawrence Shopping Center 1999 (Existing trees)*

### Projected Value of the Urban Forest

Researchers used CITYgreen and the 1999 data for the on-site trees and matured them over one and two decades. Growth projections were not made for the 3-acre forested areas. The 1999 forest patch values were added as a constant to the projected values of the landscaped trees to calculate 2009 and 2019 values.

According to CITYgreen projections the tree canopy without the forest patches increased 223% in two decades from 0.74 acres to 2.4 acres. Although the newly planted trees grew rapidly in twenty years, some of the mature trees on-site grew slower or reached their maximum sizes.

Using 1999 dollar-values the site's trees (including the forest areas) provided almost $1,300 in pollution removal benefits in 2019 by removing more than 540 pounds of pollutants. Of course the actual value would be higher because the value of the forest patch was being held at an annual constant of $737. Without including any of the forested areas, the value for air pollution removal increased 222% over twenty years from $174 to $561 annually. Using a linear progression for the twenty-year time period researchers calculated that the landscaped trees removed 3,264 pounds of pollutants, which provided about $7,850 in environmental value to the region.

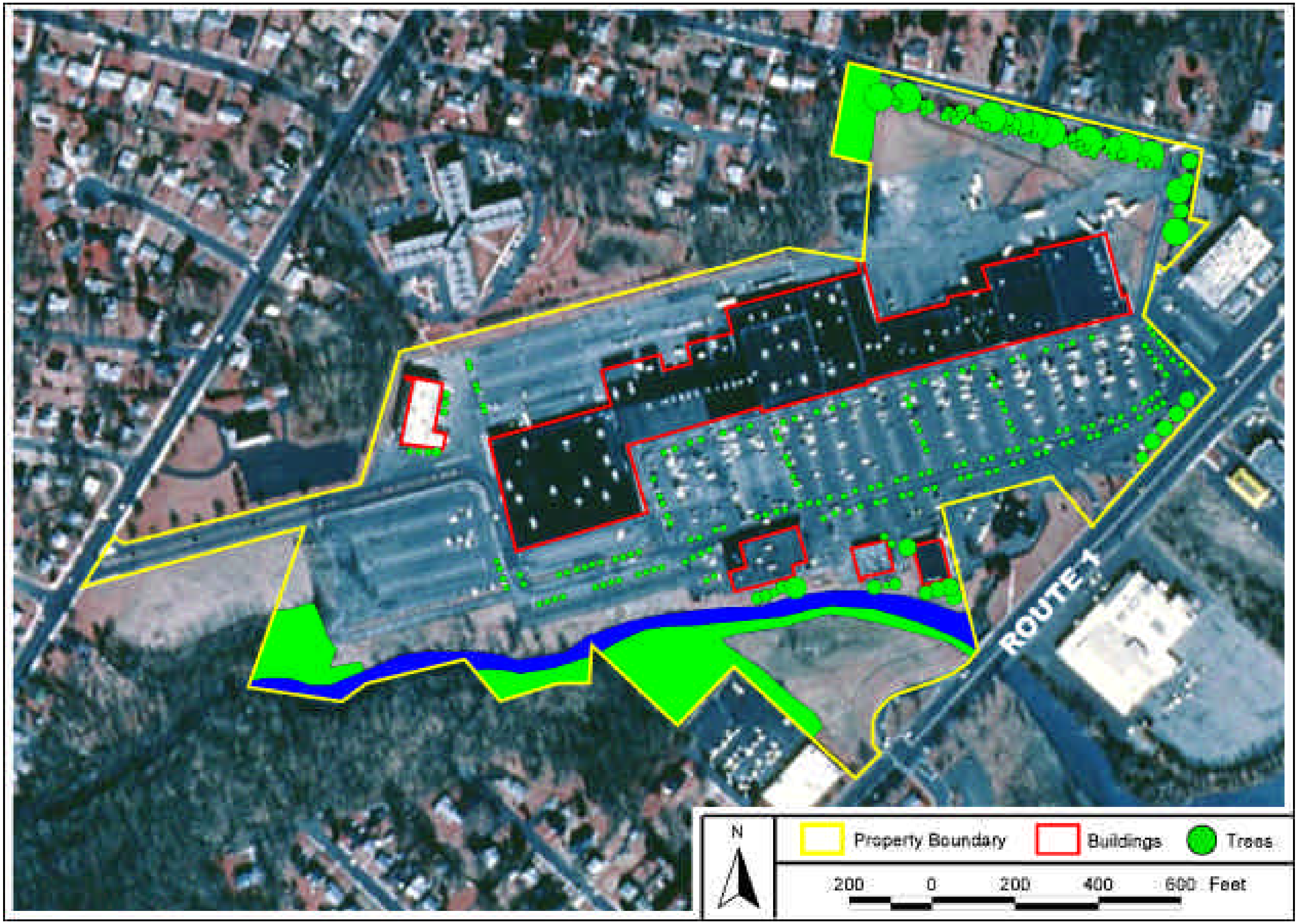
By including the forest patches, the on-site urban forests removed 9,400 pounds of air pollutants valued at $22,600 to the region over twenty years.

The trees provided additional benefits that were measured, but monetary values were unable to be determined. Using CITYgreen models and a linear progression over twenty years, researchers calculated that the landscape trees reduced the amount of stormwater runoff discharged into the streams by more than 264,000 cubic feet. By including the forested areas the total runoff discharge was reduced by 758,000 cubic feet over twenty years. The annual runoff discharged in 2019 was 228% less than the runoff in 1999. And in two decades the carbon storage capacity of the trees (without the forest patches) increased by 223% from 24 tons in 1999 to 77 tons in 2019. With the inclusion of forested areas in 2019 all the trees on the site stored about 216 tons of carbon. (figure 4.19)

**Quantifiable Benefits of Lawrence Center's Trees Projected from 1999 Site Data**

| **Environmental Benefit** | 10-YEAR GROW-OUT+FP: 2009 Tree Canopy: 4.89 acres | | | 20-YEAR GROW-OUT+FP: 2019 Tree Canopy: 5.53 acres | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 38,698 | CF | – | 43,739 | CF | – |
| Carbon Storage | 195.42 | tons | – | 216.03 | tons | – |
| Carbon Sequestration | 1.51 | tons/yr | – | 1.98 | tons/yr | – |
| Ozone Removal | 167.10 | lbs. | $512 | 188.90 | lbs. | $579 |
| SO2 Removal | 51.90 | lbs. | $39 | 58.70 | lbs. | $44 |
| NO2 Removal | 95.80 | lbs. | $294 | 108.30 | lbs. | $332 |
| PM10 Removal | 144.40 | lbs. | $296 | 163.20 | lbs. | $334 |
| CO Removal | 19.10 | lbs. | $8.31 | 21.60 | lbs. | $9.39 |
| | **VALUE per year** | | $1,149 | **VALUE per year** | | $1,298 |

*figure 4.19*




*Map 4.06: Lawrence Shopping Center 2019 (Existing trees with projected 20-year grow-out)*


# SOUTH BRUNSWICK SQUARE SHOPPING CENTER

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** unable to get an interview appointment
**Address:** 4095 US Route 1 South, Monmouth Junction, NJ 08852
**Location:** The shopping center was situated off the southbound lane of US Route 1 in South Brunswick Township, approximately 10.5 miles north of I-95/I-295 and 11 miles south of Exit 9 of the New Jersey Turnpike. It was also accessible from Wynwood Drive.

## General Site Description

South Brunswick Square Mall was a ‘Community Shopping Center’ with approximately 300,000 square feet of shopping area on the 28-acre site. Although called a mall in its name, it was a strip center with exterior canopies that connected the storefronts. The center was aligned as an obtuse ‘L’ strip with one of the anchors being unattached. The shopping center drew from a primary trade area of 3 to 6 miles.

The major anchor attached to the strip was the Grand Union supermarket. The other anchor was the Bloomingdale Furniture Clearance Store, which had been a hardware chain store. The balance of the retailers was a mix that provided convenience items and general merchandise. They consisted of liquor store, electronics stores, snack providers and restaurants, toy and bicycle stores, pet store, jeweler, dentist, travel agent, drug store, health and beauty aid stores, hair salon and spa, fitness/entertainment center, discount apparel stores and off-price merchandisers. Additionally, a bank and a restaurant chain were on the site, but not attached to the strip. An upgrade was planned for 2000. (figure 4.20)

| South Brunswick Square Mall Site Facts | |
|---|---|
| Area of Site | 28.41 acres |
| Area of Site | 0.04 square miles |
| Impervious Surface | 71.2% |
| Building Area | 7.08 acres |
| Paved Area | 13.16 acres |
| Pervious Surface | 28.8% |
| Water Surface | 0.00 acres |
| Tree Canopy Area* | 0.89 acres |
| Forest Patch Canopy Area** | 3.64 acres |
| Trees (not including forest patch areas) | 282 trees |
| Tree Species (without forest patches-FP) | 18 species |
| Tree Density | 13.22 trees/acre |
| Average Tree Ht (without FP) | 19.0 feet in Ht |
| Average Tree DBH (without FP) | 5.5 inch DBH |
| Average Tree Health*** (without FP) | 3.0 rating |
| Intrinsic Value of On-Site Trees | $162,717 |
| Tree Planting Cost (estimated by management) | not provided |
| Landscape Maintenance Cost (est. by mgmt.) | not provided |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site’s landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.20*

*Entrance with landscaped detention basin and annuals in planting beds.*

## Urban Forest and Landscape Amenities Description

- South Brunswick Square's tree canopy covered 21% of the site, including the surrounding 3.6-acre woodlands. This shopping center had the highest amount of green infrastructure in the study area for its type of commercial development.

- The 282 trees planted on-site were of mixed ages and served various functions. They were located in islands to define interior traffic patterns, define parking aisles, buffer the edge of the sight, create a welcoming entrance, cool the parking spots and naturalize the detention basin areas. None of the trees were adjacent to the building's façade.

- Eighteen species were found throughout the site with 67% of them as two species – honeylocust and white pine, 43% and 24% respectively. The remaining 33% were a mixture of sixteen species that ranged from 0.4% to 9.6% for each specie.

- The trees exhibited stress, perhaps from the region's drought.

- The detention basins ringed the perimeter of the site near both roads. It was heavily planted with various species of trees to provide seasonal impact and naturalize the basin.

- The entrances had major trees along with shrubs and seasonal flower displays that made the entrance inviting. (figure 4.21)

## Perceived Value of the Urban Forest and Landscape Amenities

Researchers were unable to interview any managers of the shopping center or any of the tenants to obtain their perception of the value of the green infrastructure on site. The only indication that management understood the value of landscaping was the high amount of landscaping that was installed during the development of the shopping center. Additionally the developers preserved a large area of forestland during the construction of the shopping center.

**South Brunswick Square Mall Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Ailanthus altissima | Tree of Heaven | 1 | 0.4% |
| Cornus florida | Dogwood, Flowering | 2 | 0.7% |
| Crataegus phaenopyrum | Hawthorn, Washington | 27 | 9.6% |
| Gleditsia triacanthos var. inermis | Honeylocust, Thornless | 122 | 43.3% |
| Ilex opaca | Holly, American | 1 | 0.4% |
| Juniperus virginiana | Cedar, Red | 3 | 1.1% |
| Liquidambar styraciflua | Sweetgum | 1 | 0.4% |
| Malus spp. | Crabapple | 15 | 5.3% |
| Picea pungens | Spruce, Colorado | 14 | 5.0% |
| Pinus strobus | Pine, Eastern White | 67 | 23.8% |
| Pinus sylvestris | Pine, Scotch | 2 | 0.7% |
| Prunus cerasifera | Plum, Purpleleaf | 2 | 0.7% |
| Prunus serrulata | Cherry, Japanese | 5 | 1.8% |
| Quercus alba | Oak, White | 1 | 0.4% |
| Quercus palustris | Oak, Pin | 2 | 0.7% |
| Quercus rubra | Oak, Red | 5 | 1.8% |
| Salix alba 'Tristis' | Willow, Weeping | 10 | 3.5% |
| Zelkova serrulata | Zelkova, Japanese | 2 | 0.7% |
| | **Total Tree Count** | **282** | **100.0%** |

*figure 4.21*


*Map 4.07: South Brunswick Square 1999 (Existing trees)*

## Quantified Value of the Urban Forest

The UFORE and CITYgreen estimated values for pollution removal by the on-site trees were similar – $180 and $208 respectively. Researchers estimated that the 282 landscape trees removed between 75 and 87 pounds of air pollutants in 1999. These trees also stored 29 tons of carbon. (Once again the calculated amounts varied from UFORE to CITYgreen – 11 tons and 29 tons respectively.)

If the 282 trees on site in 1999 were planted prior to the construction of any stormwater management systems, they reduced the on-site stormwater runoff by 7,490 cubic feet, which would have reduced the one-time costs of constructing an on-site stormwater management system by almost $12,750. The intrinsic value of the landscaped trees was estimated at approximately $163,000. A value was not calculated for the forest patches. (figure 4.22)

The protection of the 3.6-acre forest patch provided more environmental benefits to the site than the landscaped trees. The inclusion of this forestland increased the amount of air pollutants removed in 1999 by 410% (from 86 pounds to 442 pounds) for an annual value of $1,060. UFORE calculated that the landscape trees also emitted 50 pounds of VOCs as a negative effect. The forestland provided storage for an additional 161 tons of carbon, bringing the total to 189 tons. The forest patches also decreased the amount of stormwater runoff by 414% (from 7,487 cubic feet to 38,464 cubic feet). (figure 4.23)

## Projected Value of the Urban Forest

Using CITYgreen growth projections the landscaped trees in 1999 were matured over ten and twenty years. The tree canopy expanded about 108% in 20 years and covered 5.5 acres including the forested areas, which were about 19% of the site. By 2019 1.9 acres were landscaped trees. Many of the trees at South Brunswick Square were mature or showed signs of stress, therefore the growth rate percentage was less than what was projected for Lawrence Center, a site with many newly planted smaller trees.

In twenty years the amount of pollution removed annually by the landscaped trees increased 110% from 86 pounds to 181 pounds. With the 355-pound pollution removal constant assigned to the forestland, the site removed a total of 536 pounds of air pollutants in 2019 at a value of $1,288 (using 1999 values). Using a linear progression the twenty-year value provided by the landscape trees was $6,450 for removing almost 2,700 pounds of pollutants. With the inclusion of the benefits provided by the forest patches, the on-site urban forest removed almost 9,800 pounds of pollutants valued at approximately $23,500. The actual amount was more because the forest patches were not grown-out, but remained constant using the 1999 measurements and values. If the natural buffer area had been removed during construction, the regional values provided by the site would have been greatly reduced. The forestlands that were maintained during development provided the most benefits.

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
South Brunswick Square Tree Canopy: 0.89 acres (w/o forest patch)

| Environmental Benefit | UFORE Removal by Trees | | UFORE Value | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | – – | | NC | 7,487 | CF | $12,749 |
| Carbon Storage | 11.36 | tons | – | 28.59 | tons | – |
| Carbon Sequestration | 0.77 | tons/yr | – | 0.64 | tons/yr | – |
| Ozone Removal | 28.59 | lbs. | $88 | 30.20 | lbs. | $93 |
| SO2 Removal | 6.31 | lbs. | $5 | 9.40 | lbs. | $7 |
| NO2 Removal | 12.18 | lbs. | $37 | 17.30 | lbs. | $53 |
| PM10 Removal | 24.00 | lbs. | $49 | 26.10 | lbs. | $53 |
| CO Removal | 3.61 | lbs. | $1.57 | 3.50 | lbs. | $1.52 |
| | **VALUE per year** | | $180 | **VALUE per year** | | $208 |
| | | | | **with stormwater** | | $12,957 |

*figure 4.22*

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
South Brunswick Square Tree Canopy: 0.89 acres without forested area (4.53 acres w/ forests)

| Environmental Benefit | CITYgreen w/o forest patches Removal by Trees | | CITYgreen w/o forest patches Value | CITYgreen w/ forest patches Removal by Trees | | CITYgreen w/ forest patches Value |
|---|---|---|---|---|---|---|
| Stormwater Reduction | 7,487 | CF | $12,749 | 38,464 | CF | $28,408 |
| Carbon Storage | 28.59 | tons | – | 189.42 | tons | – |
| Carbon Sequestration | 0.64 | tons/yr | – | 0.92 | tons/yr | – |
| Ozone Removal | 30.20 | lbs. | $93 | 154.30 | lbs. | $473 |
| SO2 Removal | 9.40 | lbs. | $7 | 47.90 | lbs. | $36 |
| NO2 Removal | 17.30 | lbs. | $53 | 88.20 | lbs. | $270 |
| PM10 Removal | 26.10 | lbs. | $53 | 133.30 | lbs. | $273 |
| CO Removal | 3.50 | lbs. | $1.52 | 17.70 | lbs. | $7.70 |
| | **VALUE per year** | | $208 | **VALUE per year** | | $1,060 |
| | **with stormwater** | | $12,957 | **with stormwater** | | $29,467 |

*figure 4.23*

| Quantifiable Benefits of South Brunswick Square's Trees Projected from 1999 Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Environmental Benefit | 10-YEAR GROW-OUT+FP: 2009 Tree Canopy: 5.01 acres | | | | 20-YEAR GROW-OUT+FP: 2019 Tree Canopy: 5.49 acres | | | |
| | Removal by Trees | | Value | | Removal by Trees | | Value | |
| Stormwater Reduction | 42,661 | CF | $29,885 | | 46,765 | CF | $31,259 | |
| Carbon Storage | 205.19 | tons | – | | 220.58 | tons | – | |
| Carbon Sequestration | 1.28 | tons/yr | – | | 1.63 | tons/yr | – | |
| Ozone Removal | 171.00 | lbs. | $524 | | 187.30 | lbs. | $574 | |
| SO2 Removal | 53.10 | lbs. | $40 | | 58.20 | lbs. | $44 | |
| NO2 Removal | 98.10 | lbs. | $301 | | 107.40 | lbs. | $329 | |
| PM10 Removal | 147.80 | lbs. | $302 | | 161.80 | lbs. | $331 | |
| CO Removal | 19.60 | lbs. | $8.52 | | 21.50 | lbs. | $9.35 | |
| | **VALUE per year** | | $1,176 | | **VALUE per year** | | $1,288 | |

*figure 4.24*

In addition to the quantified and valued benefits the site also provided benefits where monetary values had not been assigned. By the year 2019 the carbon sequestration rate increased 111% to 1.63 tons per year, the amount of carbon stored on site increased 109% to 221 tons and the stormwater runoff was reduced 111% to 46,800 cubic feet per year. Over two decades the landscape trees and forest patches reduced the amount of stormwater runoff discharged into neighboring waterways by approximately 852,755 cubic feet. The landscape trees provided more than 233,200 cubic feet of the runoff reduction. Less runoff discharged from the sites provided better water quality. (figure 4.24)

## Strip Shopping Center Case Study Findings

The conclusions drawn from the analysis of the shopping centers were very similar to those described in the mall analysis. Older shopping centers that wanted to compete for customers and tenants needed to upgrade their sites, including their landscapes. Both Lawrence Shopping Center and Brunswick Shopping Centers were examples of sites that were losing their tenants and customers. The absence of trees and landscaping were very noticeable to customers. Their landscape renovations were planned to stem tenant and customer attrition. As their landscapes improved, so did their occupancy rate and their customer base. Even though the rents were higher, there were lower vacancies.

In addition to attractiveness, the planted parking lot islands helped traffic flow and made it safer for vehicles traveling through the site and pedestrians walking from the parking area to the stores'entrances.

The older shopping centers saw the value of using the new landscape in their marketing tools to increase occupancy. And the new updated look, which was visible from the surrounding streets brought new customers, as well as return customers who had not been to the site in awhile.

In both the older and newer sites, seasonal plantings of annuals were used at entrances. Although this was expensive and time-consuming, management felt the color and seasonal changes were necessary in attracting customers and worth the extra costs.

Although South Brunswick Square was the greenest shopping center case study, the majority of the regional benefits were provided by the forestlands that were not removed during development. Protecting existing forests provided a bigger environmental benefit to the area than planting landscape trees. The naturalized detention basins were easier to maintain and provided a buffer from the high-speed traffic that passed the site. But there had to be a compromise between the buffering function and visibility from the road, so as not to deter potential customers.

All in all, researchers projected that over twenty years the 673 trees plus the 6.8 acres of forestland on the three shopping centers would have provided $47,200 of pollution benefits by removing 19,650 pounds of air pollutants from the region. Additionally 1.7 million cubic feet of stormwater runoff would have been prevented from being discharged into the region and negatively effecting the region's water quality.

In the end shopping center managers agreed that landscaping and maintenance were an essential cost that was a good investment.

## Hotel Case Studies

Hotels were frequent along the corridor, probably because of the proximity of many corporate centers, as well as prep schools, colleges and universities (Ryder College, The College of New Jersey, Princeton University and Rutgers University). Two types were selected, one being an extended-stay type. Both reflected the high investment that hotels place on their green infrastructure.

# MARRIOTT PRINCETON RESIDENCE INN

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Requests for an interview with the general manager of were declined.
**Address:** 4225 US Route 1, Monmouth Junction, NJ 08852
**Location:** The inn was situated off the southbound lane of US Route 1 in South Brunswick Township, approximately 9 miles north of the entrance to I-95/I-295 and 12.5 miles south of Exit 9 of the New Jersey Turnpike. It was accessible off US Route 1 from Deer Park Drive.

## General Site Description

The Marriott Princeton Residence Inn was an extended-stay hotel that catered to business people staying in the area for a long term. The 9-acre site layout resembled that of apartments or condominiums in a residential development, which made their guests feel more comfortable, while being away from home. The inn opened in 1990 and had 208 rooms. It had an 80% occupancy rate with the average length of stay between 15 and 30 days per guest.

Although facing US Route 1, the site entrance was to the rear off of Deer Park Drive. The hotel was set back from the highway and buffered from it by a large retention pond that was surrounded by evergreen and deciduous trees and shrubs. (figure 4.25)

| Marriott Residence Inn Site Facts | |
|---|---|
| Area of Site | 8.77 acres |
| Area of Site | 0.01 square miles |
| Impervious Surface | 55.0% |
| Building Area | 1.39 acres |
| Paved Area | 3.43 acres |
| Pervious Surface | 45.0% |
| Water Surface | 0.44 acres |
| Tree Canopy Area* | 0.59 acres |
| Forest Patch Canopy Area** | 0.00 acres |
| Trees (not including forest patch areas) | 234 trees |
| Tree Species (without forest patches-FP) | 19 species |
| Tree Density | 31.71 trees/acre |
| Average Tree Ht (without FP) | 16.0 feet in Ht |
| Average Tree DBH (without FP) | 4.6 inch DBH |
| Average Tree Health*** (without FP) | 2.9 rating |
| Intrinsic Value of On-Site Trees | $97,316 |
| Tree Planting Cost (estimated by management) | not provided |
| Landscape Maintenance Cost (est. by mgmt.) | not provided |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.25*

## Urban Forest and Landscape Amenities Description

- The 8.8-acre site had 234 trees of 19 species planted throughout the site that created a 0.59-acre canopy and covered 7% of the site.
- The average density of trees was almost 32 trees per acre.
- Sixty percent of the trees consisted of a balance of 17 species. The amount of each species ranged from 0.4% to 13.7%. The remaining 40% were split between two smaller ornamental trees – crabapples and magnolias, 17% and 23% respectively.
- Landscaping was abundant on the site and well designed. It brought a human scale to the narrow walkways between the buildings, provided privacy in the rooms when shades were opened and created an pleasant experience while walking past the buildings to the tennis court, office building or rooms.
- The entrance included large colorful displays of flowers, shrubs, and evergreen trees.
- Woodlands abutted two sides of the site's perimeter, which shaded some of the parking areas at different times of the day. These were not on site and were not maintained by the hotel.
- The half-acre retention pond in the front of the site along US Route 1 had naturalized groups of trees along the water's edges, as well as at the top of the slope. It provided a physical buffer from the highway, as well as somewhat of a noise buffer.
- Planters and planting beds at the office entrance were rotated seasonally with flowers.
- The parking lot trees were planted in lawn areas.
- The trees needed maintenance. They averaged a 2.9 out of 5 point health rating and showed stress from an earlier drought. Staff told researchers that a new maintenance contractor was being considered. Maintenance was planned for the near future and a landscape upgrade was due. (figure 4.26)


*Rear entrance from local roadway with annuals and evergreen shrubs.*

**Marriott Residence Inn Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Acer platanoides | Maple, Norway | 5 | 2.1% |
| Acer rubrum | Maple, Red | 23 | 9.8% |
| Acer saccharum | Maple, Sugar | 4 | 1.7% |
| Amelanchier canadensis | Serviceberry, Shadblow | 1 | 0.4% |
| Betula papyrifera | Birch, Paper | 14 | 6.0% |
| Cedrus atlantica | Cedar, Atlas | 1 | 0.4% |
| Cornus florida | Dogwood, Flowering | 5 | 2.1% |
| Ilex opaca | Holly, American | 2 | 0.9% |
| Magnolia x soulangiana | Magnolia, Saucer | 54 | 23.1% |
| Malus spp. | Crabapple | 40 | 17.1% |
| Pinus strobus | Pine, Eastern White | 6 | 2.6% |
| Prunus serrulata | Cherry, Japanese | 2 | 0.9% |
| Pseudotsuga menziesii | Fir, Douglas | 2 | 0.9% |
| Pyrus calleryana | Pear, Callery | 8 | 3.4% |
| Quercus alba | Oak, White | 1 | 0.4% |
| Quercus rubra | Oak, Red | 12 | 5.1% |
| Salix alba 'Tristis' | Willow, Weeping | 15 | 6.4% |
| Tilia cordata | Linden, Littleleaf | 7 | 3.0% |
| Tsuga canadensis | Hemlock, Eastern | 32 | 13.7% |
| | **Total Tree Count** | **234** | **100.0%** |

*figure 4.26*

### Perceived Value of the Urban Forest and Landscape Amenities

Researchers were unable to interview the hotel's general manager to obtain management's perception of the value of the green infrastructure on site. Management stated that they felt the current state of the landscape was too poor to discuss. The on-site landscaping indicated that someone valued green infrastructure during the design and construction phase, because it had the highest percent of canopy cover than the other hotels along the corridor. Additionally woodlands surrounded the site, but were located on adjacent properties.

Hotel staff explained that the head office in Tennessee was responsible for all the landscape plans for the hotel and that local staff or management had very little input into the plans. The landscaping at the hotel was due to undergo an overhaul and a new landscape contractor was to be hired to maintain the site in 2000.

### Quantified Value of the Urban Forest

The canopy of 234 trees covered 0.6 acres of the 8.8 acre-site and according to CITYgreen provided an economic benefit of $138 to the region by removing approximately 57 pounds of air pollutants in 1999. The UFORE estimate was less at $97 for 1999 with the biggest differences indicated by fewer pounds of ozone and particulate matter removed by the trees. Although this site had one of the highest tree densities at 32 trees per acre, the total economic values to the region seemed low. That was because the site was smaller than the shopping center sites previously analyzed and the on-site trees were not in the best health following the drought. In addition to removing air pollutants, the trees stored approximately 19 tons of carbon at a rate of about one-half ton per year. The trees also emitted approximately 13.5 pounds of VOCs, which provided a small negative impact to the region.

The trees reduced the amount of on-site stormwater runoff by 4,036 cubic feet. If they were existing prior to construction, they would have provided a one-time cost saving of about $9,420 for the construction cost of an on-site stormwater management system. According to UFORE the intrinsic value of the on-site trees in their current condition was $97,316. (figure 4.27)

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
Marriott Residence Inn Tree Canopy: 0.59 acres

| Environmental Benefit | UFORE | | CITYgreen | |
|---|---|---|---|---|
| | Removal by Trees | Value | Removal by Trees | Value |
| Stormwater Reduction | – – | NC | 4,036 CF | $9,421 |
| Carbon Storage | 12.54 tons | – | 18.95 tons | – |
| Carbon Sequestration | 0.49 tons/yr | – | 0.43 tons/yr | – |
| Ozone Removal | 15.60 lbs. | $48 | 20.10 lbs. | $62 |
| SO2 Removal | 3.51 lbs. | $3 | 6.20 lbs. | $5 |
| NO2 Removal | 6.51 lbs. | $20 | 11.50 lbs. | $35 |
| PM10 Removal | 12.38 lbs. | $25 | 17.30 lbs. | $35 |
| CO Removal | 2.43 lbs. | $1.06 | 2.30 lbs. | $1.00 |
| | **VALUE per year** | $97 | **VALUE per year** | $138 |
| | | | **with stormwater** | $9,559 |

*figure 4.27*


*Map 4.07: Marriott Princeton Residence Inn 1999 (Existing trees)*

## Projected Value of the Urban Forest

Using CITYgreen growth projections the 234 existing trees were grown-out over ten and twenty-year periods. By the year 2019 the 0.6-acre canopy expanded 224% to almost two acres. By 2019 the trees removed 187 pounds of air pollutants annually at a value of about $450 – a 226% increase in pollution removal over two decades. Using a linear progression from 1999 to 2019 and 1999 monetary values, researchers calculated that the trees removed 2,690 pounds of air pollutants valued at $6,460 to the region.

In addition to quantified and valued benefits the site also provided benefits where monetary values had not been assigned. By the year 2019 the annual carbon sequestration rate increased 223% to 1.4 tons per year, the amount of carbon stored on site increased 226% to 62 tons and the stormwater runoff was reduced 228% at 13,248 cubic feet per year. Over two decades the on-site urban forests reduced the amount of stormwater runoff discharged into neighboring waterways by approximately 190,130 cubic feet, which improved the quality of our regional watersheds. (figure 4.28)

**Quantifiable Benefits of Marriott Residence Inn's Trees Projected from 1999 Data**

| Environmental Benefit | 10-YEAR GROW-OUT: 2009 Tree Canopy: 1.50 acres | | | 20-YEAR GROW-OUT: 2019 Tree Canopy: 1.91 acres | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 10,371 | CF | – | 13,248 | CF | – |
| Carbon Storage | 48.43 | tons | – | 61.73 | tons | – |
| Carbon Sequestration | 1.09 | tons/yr | – | 1.39 | tons/yr | – |
| Ozone Removal | 51.20 | lbs. | $157 | 65.30 | lbs. | $200 |
| SO2 Removal | 15.90 | lbs. | $12 | 20.30 | lbs. | $15 |
| NO2 Removal | 29.40 | lbs. | $90 | 37.50 | lbs. | $115 |
| PM10 Removal | 44.30 | lbs. | $91 | 56.40 | lbs. | $115 |
| CO Removal | 5.90 | lbs. | $2.57 | 7.50 | lbs. | $3.26 |
| | **VALUE per year** | $352 | | **VALUE per year** | $449 | |

*figure 4.28*

# COURTYARD BY MARRIOTT

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Mr. Joseph Sirianni, General Manager
**Address:** 3815 US Route 1, Princeton, NJ 08540
**Location:** The hotel was located off the southbound lane of US Route 1 in Plainsboro Township, approximately 5.5 miles north of I-95/I-295 and 16 miles south of Exit 9 of the New Jersey Turnpike. It was accessible from US Route 1 off of Mapleton Road.

## General Site Description

The Courtyard by Marriott was a mid-range business hotel on about 5 acres that catered mostly toward business clientele. The hotel opened in the summer of 1999. It had 154 rooms that were mostly 100% occupied between Monday and Thursday with an 80% annual occupancy average. The courtyard was enclosed by walls and had a gazebo and garden for the clients and employees.

The site plans and architectural plans were approved by the Marriott Company and carried out by Watson Hospitality, the franchisee. Marriott specified minimum landscape standards as part of the plan. Local requirements required these standards to be raised. In the case of this hotel the township required a larger level of landscaping to meet certificate of occupancy requirements. (figure 4.29)

| Courtyard by Marriott Site Facts | | |
|---|---|---|
| Area of Site | 4.62 | acres |
| Area of Site | 0.01 | square miles |
| Impervious Surface | 59.7% | |
| Building Area | 0.61 | acres |
| Paved Area | 2.15 | acres |
| Pervious Surface | 40.3% | |
| Water Surface | 0.00 | acres |
| Tree Canopy Area* | 0.09 | acres |
| Forest Patch Canopy Area** | 0.00 | acres |
| Trees (not including forest patch areas) | 248 | trees |
| Tree Species (without forest patches-FP) | 7 | species |
| Tree Density | 61.85 | trees/acre |
| Average Tree Ht (without FP) | 8.0 | feet in Ht |
| Average Tree DBH (without FP) | 2.1 | inch DBH |
| Average Tree Health*** (without FP) | 4.0 | rating |
| Intrinsic Value of On-Site Trees | not | calculated |
| Flower Beds | $3,000 | per rotation |
| Tree Planting Cost (estimated by management) | not | provided |
| Landscape Maintenance Cost (est. by mgmt.) | $30,000 | /year |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and includes those in parking areas, entrances, buffers and detention basin areas.*

** *The canopy of natural woodland areas that remained after site development. Data was not collected for the individual trees, rather generalized factors for the forest composition was recorded.*

*** *Tree Health is based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.29*


*Bermed hillside adjacent to highway buffered roadway noise and provided better views from hotel rooms looking outward.*

## Urban Forest and Landscape Amenities Description

- Although Courtyard by Marriott had the smallest percentage of tree canopy (less than 2%) of those sites, it was not for lack of trees. Rather it was a new hotel that had been recently built on a site where an old building was removed. There had been fields without any mature trees on site. Therefore the 248 newly planted trees only formed a canopy of 3,920 square feet, less than one-tenth of an acre, but had the highest density of trees at 62 trees per acre. That was almost twice the density of the site with the next highest amount in the study.

- The newly planted trees were quite small, averaging 8 feet in height and 2 inches in caliper. However they received a health rating of 4 out of 5, which was quite good relative to the recent drought that effected many other sites landscaping.

- Seventy percent of the trees were of two species red maple (21%) and American holly (49%). The hollies were mostly used as a buffer to the residential neighborhood. That was a high amount of one species to be planted on the 4.6- acre site.

- The remaining 30% of the trees were of five species and ranged from 3% to 12% for a single species.

- The pristine landscape at the Courtyard by Marriott consisted of seasonal flower beds around the main entrance. These beds contained colorful pansies protected with mulch. At the time of the interview the hotel was one of few establishments along this commercial corridor that had eschewed ornamental cabbages as their seasonal planting. Mr. Sirianni was pleased to be different.

- The hotel had gone through a number of seasonal rotations of flower bed plantings and management was in a position to make improvements and changes to the overall design. The management planned to reduce the number of rotational flower bed plantings. They planned to replace these areas with a variety of shrubs that flower in different times of year to decrease their maintenance efforts and costs.

- Trees were planted at intervals throughout the parking lot in lawn areas and planting islands.

- An exterior walkway for guests was lined with young trees and located on a berm that separated the path from the parking area.

- Shrubs and ornamental trees were planted in beds against all of the hotel's exterior walls.

- A courtyard enclosed by walls at the rear of the hotel was accessible from the lounge area of the hotel. It had lawn areas with paths leading to a central gazebo structure. The planting beds had seasonal plantings and small ornamental trees. (figure 4.30)

| Courtyard by Marriott Tree Statistics | | | |
|---|---|---|---|
| **Scientific name** | **Common Name** | **Count** | **Percent** |
| Acer rubrum | Maple, Red | 53 | 21.4% |
| Cornus florida | Dogwood, Flowering | 8 | 3.2% |
| Ilex opaca | Holly, American | 121 | 48.8% |
| Malus spp. | Crabapple | 12 | 4.8% |
| Prunus serrulata | Cherry, Japanese | 18 | 7.3% |
| Quercus rubra | Oak, Red | 7 | 2.8% |
| Zelkova serrulata | Zelkova, Japanese | 29 | 11.7% |
| | **Total Tree Count** | **248** | **100.0%** |

*figure 4.30*

## Perceived Value of the Urban Forest and Landscape Amenities

**To Hotel Management:**

- Landscaping was considered very important in the hotel industry for projecting an image to the guests and competing with the neighboring hotels. The landscaping was used in the promotional material for the hotel.
- Mr. Sirianni felt that the landscaping at this Courtyard by Marriott compared favorably with other hotels in the area. In fact he felt that it would exceed the level of its competitors once the landscape matured over the years.
- As a business person's hotel, it was essential to generate a good feeling. The landscaped courtyard was one amenity that created a welcoming and relaxing atmosphere for the guests.
- In order to reduce traffic noise the management was contemplating planting trees along the lawn area and berm that separated the hotel from US Route 1. The decision had to be balanced against needed visibility along the highway.
- Although the seasonal plantings were being decreased, management felt they had the highest visual impact in the landscape.
- Maintenance of the landscape was time consuming for hotel management. Mr. Sirianni inspected the exterior of the hotel every day and once a week he and his assistant managers walked the entire site looking for problems.

**To Customers/Guests:**

- The landscape was the first thing that guests noticed and first impressions were very important as to whether they selected to stay at one hotel or another.
- Mr. Sirianni sensed that their well-maintained lawns and landscapes indicated that this Courtyard by Marriott was a well-maintained hotel.
- Management also believed that customers appreciated and valued landscaping, especially in summer when they experienced the courtyard gardens.
- Mr. Sirianni pointed out that good landscaping, like good service, was something that encouraged guests to return.

## Quantified Value of the Urban Forest

The Courtyard by Marriott was the only case study site where UFORE was not used in a parallel analysis; only CITYgreen was used. The 248 small newly planted trees provided a canopy that covered only 2% of the site – almost one-tenth of an acre. These trees removed 8.5 pounds of air pollutants at a value of $21 to the region.

They also reduced the amount of on-site runoff by 702 cubic feet, which provided a one-time construction cost reduction for stormwater management of $4,002. Additionally the trees stored almost 3 tons of carbon. Although the amounts are low, they were expected because all 248 trees are newly planted with an average height of 8 feet and diameter at breast height (dbh) of 2 inches. Because UFORE was not used, there were no calculations for VOC emissions or the intrinsic value of the landscape trees. (figure 4.31)

**Quantifiable Benefits of Trees Derived from 1999 Data**
Courtyard by Marriott Tree Canopy: 0.09 acres

| Environmental Benefit | CITYgreen Removal by Trees | | CITYgreen Value |
|---|---|---|---|
| Stormwater Reduction | 702 | CF | $4,002 |
| Carbon Storage | 2.88 | tons | – |
| Carbon Sequestration | 0.07 | tons/yr | – |
| Ozone Removal | 3.00 | lbs. | $9 |
| SO2 Removal | 0.90 | lbs. | $1 |
| NO2 Removal | 1.70 | lbs. | $5 |
| PM10 Removal | 2.60 | lbs. | $5 |
| CO Removal | 0.30 | lbs. | $0.13 |
| | **VALUE per year** | | $21 |
| | **with stormwater** | | $4,022 |

*figure 4.31*


*Map 4.08: Courtyard by Marriott 1999 (Existing trees laid over aerial photograph of prior building on the site.)*

## Projected Value of the Urban Forest

The existing trees were grown-out for ten and twenty years using CITYgreen growth projections. The Courtyard by Marriott had the highest density of trees as compared to all the other case study sites – 62 trees per acre, but it also had the smallest trees in 1999. In the first ten years the tree canopy expanded 689% to cover 0.71 acres. By 2019 the tree canopy grew to cover 1.3 acres, which was a 1,378% increase in size from 1999. As the canopy expanded, so did the values of the benefits it provided. In pollution removal alone, the trees removed 130 pounds of pollutants, a 1,431% increase in twenty years. The annual pollutant removal value also increased to $313 for 2019.

Using a linear progression for the two decades from 1999 to 2019, the benefits and associated values for the on-site trees were calculated. They removed about 1,391 pounds of air pollutants at a twenty-year value of $3,340 to the region.

Additionally the trees provided benefits to the region that had no calculated monetary values. The tree increased their carbon storage capacity 1,395% in 20 years from 2 tons to 43 tons.

And the annual amount of stormwater runoff was reduced by 1,395% from 702 cubic feet per year to 10,492 cubic feet per year. Researchers calculated that the trees reduced the amount of stormwater runoff discharged into the streams by more than 111,560 cubic feet in two decades. After twenty years the trees would still be growing, continuing to provide more and more benefits to the region. Although the measured benefits were smaller than those provided on other sites, the percent improvements were phenomenal as the young trees on the site matured. (figure 4.32)

**Quantifiable Benefits of Courtyard by Marriott 's Trees Projected from 1999 Data**

| Environmental Benefit | 10-YEAR GROW-OUT: 2009<br>Tree Canopy: 0.71 acres | | | 20-YEAR GROW-OUT: 2019<br>Tree Canopy: 1.33 acres | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 5,559 | CF | $11,020 | 10,492 | CF | $15,039 |
| Carbon Storage | 22.99 | tons | – | 43.05 | tons | – |
| Carbon Sequestration | 0.52 | tons/yr | – | 0.97 | tons/yr | – |
| Ozone Removal | 24.30 | lbs. | $74 | 45.60 | lbs. | $140 |
| SO2 Removal | 7.60 | lbs. | $6 | 14.10 | lbs. | $11 |
| NO2 Removal | 13.90 | lbs. | $43 | 26.10 | lbs. | $80 |
| PM10 Removal | 21.00 | lbs. | $43 | 39.40 | lbs. | $81 |
| CO Removal | 2.80 | lbs. | $1.22 | 5.20 | lbs. | $2.26 |
| | **VALUE per year** | | $167 | **VALUE per year** | | $313 |

*figure 4.32*


*Map 4.09: Courtyard by Marriott 2019 ( Existing trees with projected 20-year grow-out)*

## Hotel Case Study Findings

Landscaping was considered very important in the hotel industry. The landscape was the first thing that guests noticed about a hotel and first impressions were very important. A well-maintained lawn and landscape indicated a well-maintained hotel. The landscape was often used in the promotional materials to market the hotels to potential guests.

Upscale landscape did not suggest upscale hotels, because many mid-range hotels invested in the landscape to attract customers that passed by the site. Landscaping was also used at both sites to provide a human scale and a relaxing atmosphere for the guests. This was especially important because they catered to business people who stayed for extended periods and could be return guests.

Because hotels were often adjacent to noisy, unattractive, barren highways, the landscape had to provide a noise and visual buffer, while at the same time remaining visible from the road. The landscape was important to competing with others in the hotel business, whether through exterior buffers and entrances or interior courtyards and gardens.

The two hotels covered only 13 acres along the US Route 1 corridor, but the 482 landscape trees removed 4,080 pounds of air pollutants over twenty years, valued at $9,800 to the region. Additionally researchers projected that in the same twenty-year period they reduced the amount of stormwater runoff discharged into the region’s watershed by 302,000 cubic feet.

## D o w n t o w n B u s i n e s s I m p r o v e m e n t D i s t r i c t C a s e S t u d i e s

Business Improvement Districts (BIDs) formed a sample that represented the diverse nature of commercial districts in New York City. They were defined districts with groups of commercial entities, which allowed researchers to study them as a group of businesses, rather than as isolated businesses. As a sample population they had active redevelopment activities that were intimately involved with external aspects, including greening efforts that could be evaluated. Four sites were selected from Manhattan Borough (County) as case studies: 47th Street BID, 8th Street BID, Bryant Park Restoration BID and 34th Street Partnership BID.

# 3 4 T H S T R E E T P A R T N E R S H I P a n d B R Y A N T P A R K R E S T O R A T I O N B I D S

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Maureen Hackett, Staff Horticulturist (Because one person was interviewed for both BID sites the case studies have been combined.)
**Address:** 500 Fifth Avenue, New York, NY 10110
**Location:** Both BIDs were irregularly shaped districts. In general, the boundaries of the 34th Street BID were Park Avenue on the east, 10th Avenue on the west, 31st Street on the south (with a small extension to 31st Street), and 35th Street on the north (with one block along 36th Street). The Bryant Park BID boundaries were Fifth Avenue on the east, Sixth Avenue (Avenue of the Americas) on the west, 40th Street on the south (with a small extension to 39th Street), and 43rd Street on the north.

| 34th Street Partnership BID Site Facts | | |
|---|---|---|
| Area of Site | 122.12 | acres |
| Area of Site | 0.19 | square miles |
| Street Length | 5.50 | linear miles |
| Tree Canopy Area* | 0.74 | acres |
| *Tree Canopy Area of Proposed Trees*** | *4.05* | *acres* |
| Trees | 291 | trees |
| *Potential Trees (Max. Proposed)* | *1,593* | *trees* |
| Tree Species | 10 | species |
| Tree Density (existing) | 2.38 | trees/acre |
| Average Tree Ht | 21.6 | feet in Ht |
| Average Tree DBH | 6.0 | inch DBH |
| Average Tree Health*** | 2.9 | rating |
| Intrinsic Value of On-Site Trees | $144,386 | |
| Tree Planting Cost (estimated by mgmt.)**** | $5,000 + | /tree |
| Landscape Installation Budget (est. by mgmt.) | $500,000 | /year |
| Landscape Maintenance Budget (est. by mgmt.) | $130,000 | /year |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and included those in sidewalk tree pits, on-site park land and containers.*

** *The collective canopy of the estimated maximum number of individual trees that could be planted throughout the site, including existing and proposed trees in sidewalk tree pits, on-site park land and containers.*

*** *Tree Health was based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

**** *Average installation cost was $5,000 to $7,000 on sidewalk, including planting 4" caliper tree, cutting concrete, installing belgium block pavers, protection bollards and tree identification signs.*

*figure 4.33*

## G e n e r a l S i t e D e s c r i p t i o n s

The 34th Street Partnership BID was the largest of the BIDs studied in this project – 0.2 square miles (122 acres). Broadway and Sixth Avenue were very busy commercial strips with large stores such as Macy's and the 34th Street Mall that contained a Sterns Department store, Toys R Us, Kids R Us etc. Electronics shops and offices lined the avenues and side streets. Shoe and apparel chain stores like The Gap, as well as a mix of chain and independent restaurants did business in this area. Madison Square Garden, Barnes & Noble and the beginning of the garment district were found on Seventh Avenue below 34th Street. The diversity of this BID was very obvious on 32nd Street, which was known as 'Little Korea'and contained restaurants and hotels catering to this ethnic group and tourists. The western end of the BID was somewhat run-down with older buildings and independent low-end apparel stores and food shops. The entire area was congested with pedestrian traffic made up of office workers, tourists and shoppers. Two parks in the BID, Harold Square and Greeley Square, provided a respite from the surrounding traffic noise and crowds. These squares have been restored and contained benches beneath shade trees. The new amenities in these parks were considered safer and more people friendly than a few years ago. (figure 4.33)

The Bryant Park Restoration BID encompassed 40th to 42nd Streets from Fifth Avenue to Sixth Avenue (Avenue of the Americas), which contained Bryant Park and the New York City Library. There was also one upscale restaurant and one café with outdoor seating. The stores that faced the park were considered to be part of the BID. These stores were a mix of independent clothing, jewelry and shoe shops. A number of office buildings, two residential buildings and chain stores such as Pier One and a Roy Rogers Food Court made up the rest of the BID. Tourists, office workers and shoppers frequented this area. (figure 4.34)

| Bryant Park Restoration BID Site Facts | | |
|---|---|---|
| Area of Site | 26.08 | acres |
| Area of Site | 0.04 | square miles |
| Street Length | 1.06 | linear miles |
| Tree Canopy Area* | 1.49 | acres |
| *Tree Canopy Area of Proposed Trees*** | *1.58* | *acres* |
| Trees | 270 | trees |
| *Potential Trees (Max. Proposed)* | *286* | *trees* |
| Tree Species | 9 | species |
| Tree Density | 10.35 | trees/acre |
| Average Tree Ht | 34.7 | feet in Ht |
| Average Tree DBH | 2.6 | inch DBH |
| Average Tree Health*** | 3.0 | rating |
| Intrinsic Value of On-Site Trees | $42,955 | |
| Tree Planting Cost (estimated by mgmt.)**** | $1,500 | /tree |
| Landscape Installation Budget (est. by mgmt.) | see 34th | St BID |
| Landscape Maintenance Budgt (est. by mgmt.) | see 34th | St BID |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and included those in sidewalk tree pits, on-site park land and containers.*

** *The collective canopy of the estimated maximum number of individual trees that could be planted throughout the site, including existing and proposed trees in sidewalk tree pits, on-site park land and containers.*

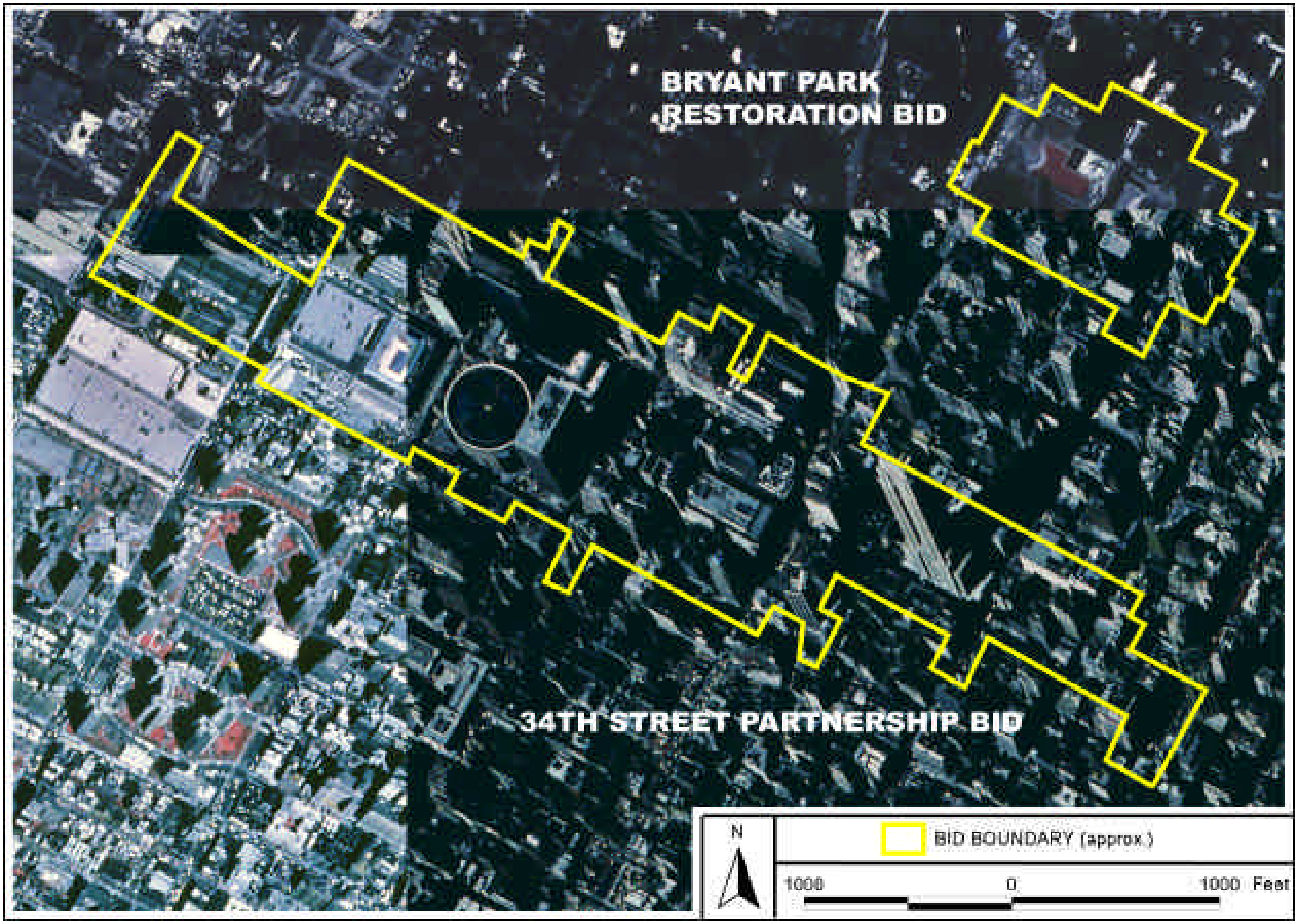
*** *Tree Health was based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

**** *Average installation cost was $1,500 in the park and $5,000 to $7,000 on sidewalk, including planting 4" caliper tree, cutting concrete, installing belgium block pavers, protection bollards and tree identification signs.*

*figure 4.34*

*34th Street Partnership BID*

*Bryant Park Restoration BID*




*Map 4.10: Bryant Park Restoration BID & 34th Street Partnership BID*

## Urban Forest and Landscape Amenities Description

- The greening of the 34th Street BID and Bryant Park BID was part of an ongoing project that involved private professionals, such as engineers and landscape architects, city and state departments, as well as preservation, municipal and community groups. These included NY City Department of Parks and Recreation, NYC Department of Transportation, NYC Department of Design and Construction, Landmarks and City Planning, Association for a Better New York and Community Boards Four, Five and Six.

- Extensive landscaping activities from 1994 to 1997 were undertaken to beautify the BIDs. Since 1997 smaller BID specific projects were undertaken. The current landscape amenities were the result of an inclusive planning process that included the various department and groups listed above. The staff horticulturist reviewed the plans and had final approval on the new landscape.

- The staff horticulturist considered the landscaping in these BIDs to be above average when compared with anything else in the city, as well as cityscapes nationally and internationally.

- In these BIDs such physical attributes as vaults, narrow sidewalks, underground utilities, street lighting requirements and the presence of large public spaces contributed to the complex nature of the landscape plan.

- The plantings included street trees, ornamental flower plantings in the parks and other green spaces in the BIDS. Container shrubs, flowers, trees, seasonal plantings and hanging baskets enhanced the overall look of the area.

- Tree guards protected the street trees from both pedestrian and motor traffic.

- Where vaults precluded the actual planting of a tree, containers were placed underground and trees were planted in them to restrict root damage to vaults and other underground obstacles.

- Before 1997 400 trees grew in the area. In 1999 six new trees were added to the area.

- The average installation cost for trees in the park was $1,500 per tree.

- The installation costs for sidewalk trees ranged from $5,000 to $7,000. This included planting a 4-inch caliper tree, cutting the concrete, and installing belgium block pavers, protection bollards and tree identification signs.

- 81% of Bryant Park was of one species, London Plane. Although it is an extremely high percentage for one species, it was maintained at this percentage to honor the historic planting in the area.

- Between the two BIDs there were 14 tree species. All other tree species were less than 14% with the exception of a high percentage of Callery pear trees – 43% in the 34th Street BID.

- The average health of the trees in both BIDS was rated at 3.

- The trees in the 34th Street BID were of a larger caliper; averaging 6-inch dbh and 22 feet tall. The Bryant Park trees averaged to be 35 feet tall, but had a smaller average diameter measurement – 2.6-inch dbh. (figures 4.35 and 4.36)

**34th Street Partnership BID Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Acer palmatum | Maple, Japanese | 6 | 2.1% |
| Ailanthus altissima | Tree of Heaven | 42 | 14.4% |
| Betula papyrifera | Birch, Paper | 15 | 5.2% |
| Fagus grandifolia | American Beech | 15 | 5.2% |
| Gleditsia triacanthos var. inermis | Honeylocust, Thornless | 25 | 8.6% |
| Platanus x acerifolia | Planetree, London | 29 | 10.0% |
| Prunus serrulata | Cherry, Japanese | 2 | 0.7% |
| Pyrus calleryana | Pear, Callery | 126 | 43.3% |
| Sophora japonica | Pagoda Tree, Japanese | 5 | 1.7% |
| Zelkova serrulata | Zelkova, Japanese | 26 | 8.9% |
| | **Total Tree Count** | **291** | **100.0%** |

*figure 4.35*

**Bryant Park Restoration BID Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Ailanthus altissima | Tree of Heaven | 1 | 0.4% |
| Ginkgo biloba | Ginkgo | 4 | 1.5% |
| Gleditsia triacanthos var. inermis | Honeylocust, Thornless | 19 | 7.0% |
| Magnolia grandiflora | Magnolia,Southern | 2 | 0.7% |
| Picea pungens | Spruce, Colorado | 20 | 7.4% |
| Platanus x acerifolia | Planetree, London | 218 | 80.7% |
| Prunus serrulata | Cherry, Japanese | 3 | 1.1% |
| Pyrus calleryana | Pear, Callery | 1 | 0.4% |
| Quercus palustris | Oak, Pin | 2 | 0.7% |
| | **Total Tree Count** | **270** | **100.0%** |

*figure 4.36*

*34th Street Partnership BID*

*Bryant Park Restoration BID*

## Perceived Value of the Urban Forest and Landscape Amenities

**To BID Staff:**

- The most influential factors that were considered when the landscape investment was under discussion were environmental, aesthetic, social, economic and real estate values.
- The overall design concept was to improve the district's aesthetics and environment that would lead to social and economic improvements.
- Horticultural security was an issue, as theft and vandalism of plants represented about 20% of the overall maintenance budget.
- An increase in the maintenance budget would be very welcome in this BID. Planting 4-inch caliper trees reduced maintenance costs, however up-front installation costs were higher. A 4-inch caliper tree had a higher rate of survival in the urban environment.
- Although trees accounted for a high proportion of the overall installation budget, staff considered trees to be the best landscape investment.
- The positive changes have created a feeling of prosperity for the BID as a whole.
- Landscape improvements were considered as important as sanitation and security improvements in affecting economic improvement.

**To Commercial Tenants/Merchants:**

- When consulted about landscape plans, merchants were aware that greener areas suffer less vandalism and that the attitudes of shoppers were more positive in landscaped areas.
- Property values in the BID have doubled following the landscaping and other BID activities to clean up the area. Since the BID carried out improvements, the vacancy rate has decreased dramatically. Prior to the BID, a 20% vacancy rate was normal. At the time of the interview the area had 100% occupancy.
- This increase in occupancy led to an increase in commercial property rent.
- Merchants have also noticed an increase in customers.

**To Customers:**

- The trees brought a human scale to areas where tall massive buildings were the norm.
- Shoppers and tourists lingered longer in the areas that were attractive and seemed safer.

## Quantified Value of the Urban Forest

In 1999 the 291 trees within the 34th Street BID formed a canopy of 0.74 acres, less than 1% of the BID. The street trees removed between 59 pounds (UFORE) and 87 pounds (CITYgreen) of air pollutants from the region. CITYgreen placed a value for that annual benefit to be $206. According to UFORE the trees also emitted 13.5 pounds of VOCs. The models provided varying results once again for the amount of carbon stored by the trees – 13 tons (UFORE) versus 24 tons (CITYgreen). The presence of these trees reduced the amount of stormwater runoff by 7,713 cubic feet. No monetary value was assigned for reducing runoff in the BIDs. Reducing runoff was a great benefit in these urban areas with high amount of impervious surfaces. UFORE calculated the intrinsic value of the 291 trees as $144,386. (figure 4.37)

According to UFORE the real value of the 270 trees in the Bryant Park BID was $42,955. They created a canopy of 1.5 acres, about 6% of the 26-acre BID. The trees removed between 146 pounds and 177 pounds of air pollutants from the region in 1999, which was valued at approximately $419. The high percentage of planetrees in the park created a negative impact by emitting 100 pounds of VOCs, still less than the positive benefits of pollutant removal. Once again the calculated amount of carbon stored by the trees varied greatly – 1.7 tons (UFORE) versus 48 tons (CG). (figure 4.38)

Researchers calculated the maximum number of trees that could be planted in the 122-acre 34th Street BID as 1,593 trees – a 450% increase in quantity. The canopy would cover 4 acres, about 3% of the site. If those trees were in the BID in 1999 the amount of air pollutant removal would increase to 476 pounds versus the 87 pounds removed by the existing trees. The proposed trees would also remove more than 42,000 cubic feet of stormwater runoff in the BID. (figure 4.39)

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
34th Street BID Tree Canopy: 0.74 acres

| Environmental Benefit | UFORE | | | CITYgreen | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | – – | | NC | 7,713 | CF | NC |
| Carbon Storage | 13.16 | tons | – | 23.64 | tons | – |
| Carbon Sequestration | 0.93 | tons/yr | – | 0.53 | tons/yr | – |
| Ozone Removal | 17.00 | lbs. | $52 | 24.40 | lbs. | $75 |
| SO2 Removal | 8.50 | lbs. | $6 | 10.30 | lbs. | $8 |
| NO2 Removal | 14.79 | lbs. | $45 | 24.30 | lbs. | $74 |
| PM10 Removal | 13.90 | lbs. | $28 | 23.10 | lbs. | $47 |
| CO Removal | 4.80 | lbs. | $2.09 | 4.80 | lbs. | $2.09 |
| | **VALUE per year** | | $134 | **VALUE per year** | | $206 |

*figure 4.37*

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
Bryant Park BID Tree Canopy: 1.49 acres

| Environmental Benefit | UFORE | | | CITYgreen | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | – – | | NC | 15,733 | CF | NC |
| Carbon Storage | 1.72 | tons | – | 48.12 | tons | – |
| Carbon Sequestration | 0.35 | tons/yr | – | 1.08 | tons/yr | – |
| Ozone Removal | 41.93 | lbs. | $129 | 49.50 | lbs. | $152 |
| SO2 Removal | 20.08 | lbs. | $15 | 21.00 | lbs. | $16 |
| NO2 Removal | 38.26 | lbs. | $117 | 49.30 | lbs. | $151 |
| PM10 Removal | 36.14 | lbs. | $74 | 47.00 | lbs. | $96 |
| CO Removal | 9.64 | lbs. | $4.19 | 9.70 | lbs. | $4.22 |
| | **VALUE per year** | | $339 | **VALUE per year** | | $419 |

*figure 4.38*

| Environmental Benefit | EXISTING SITE DATA : 1999 | | | SITE w/ MAX TREES PLANTED | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 7,713 | CF | NC | 42,223 | CF | NC |
| Carbon Storage | 23.64 | tons | – | 129.41 | tons | – |
| Carbon Sequestration | 0.53 | tons/yr | – | 2.90 | tons/yr | – |
| Ozone Removal | 24.40 | lbs. | $75 | 133.57 | lbs. | $409 |
| SO2 Removal | 10.30 | lbs. | $8 | 56.38 | lbs. | $42 |
| NO2 Removal | 24.30 | lbs. | $74 | 133.02 | lbs. | $408 |
| PM10 Removal | 23.10 | lbs. | $47 | 126.45 | lbs. | $259 |
| CO Removal | 4.80 | lbs. | $2.09 | 26.28 | lbs. | $11.43 |
| | **VALUE per year** | | $206 | **VALUE per year** | | $1,130 |

*figure 4.39*

When researchers calculated the maximum quantity of trees for the Bryant Park BID, it seemed the BID was almost at its maximum density of 10.3 trees per acre. Thus the maximum number of trees was set at 286 trees. The fallacy with this calculation was that the number of maximum trees for a BID was based on linear feet of roadway to determine numbers of street trees. Many of the existing trees were in the park, rather than as street trees. In actuality, the BID could plant more than sixteen additional street trees.

The canopy would increase slightly to 1.6 acres to assist in the removal of 187 pounds of air pollutants valued at $444. And 16,665 cubic feet of stormwater runoff would be prevented from being discharged into the city's stormwater system. (figure 4.40)

## Projected Value of the Urban Forest

Using CITYgreen and the proposed maximum number of trees for each BID, the trees were matured over two decades. Using a 1999 monetary value, the proposed trees in the 34th Street BID provided $11,740 worth of air pollution removal benefits in 2019 by removing more than 4,900 pounds of pollutants. By 2019 the tree canopy covered 42 acres, more than a 900% increase. The amount of carbon stored by the trees in the BID was 1,345 tons and the stormwater runoff was drastically reduced. In 2019 the trees prevented almost 440,000 cubic feet of runoff from being discharged.

Researchers used a linear progression for the twenty-year period from 1999 to 2019 and calculated the benefits provided by the proposed trees and their associated values. The trees removed about 66,375 pounds of air pollutants at an estimated value of $157,632 to the city (using 1999 monetary values). Additionally in the same period the green infrastructure in the BID prevented 5.9 million cubic feet of stormwater runoff from being discharged into the city. (figure 4.41)

The proposed maximum amount of trees for the Bryant Park BID were also grown out over ten and twenty years. In 2019 the tree canopy covered 1.8 acres, almost 7% of the BID. The trees that created this canopy removed 210 pounds of air pollutants in 2019 at a value of almost $500. They also stored approximately 57 tons of carbon.

Researchers used a linear progression for the twenty-year period to calculate the benefits provided by the proposed trees and the associated values. The trees removed 3,865 pounds of air pollutants at an estimated value of $9,175 to the city using 1999 monetary values. Additionally over that same time period the trees prevented almost 345,000 cubic feet of stormwater runoff from being discharged into the city's system. (figure 4.42)

**Quantifiable Benefits of Bryant Park BID Trees - Existing & Proposed Maximum**

| Environmental Benefit | EXISTING SITE DATA : 1999 | | | SITE w/ MAX TREES PLANTED | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 15,733 | CF | NC | 16,665 | CF | NC |
| Carbon Storage | 48.12 | tons | – | 50.97 | tons | – |
| Carbon Sequestration | 1.08 | tons/yr | – | 1.14 | tons/yr | – |
| Ozone Removal | 49.50 | lbs. | $152 | 52.43 | lbs. | $161 |
| SO2 Removal | 21.00 | lbs. | $16 | 22.24 | lbs. | $17 |
| NO2 Removal | 49.30 | lbs. | $151 | 52.22 | lbs. | $160 |
| PM10 Removal | 47.00 | lbs. | $96 | 49.79 | lbs. | $102 |
| CO Removal | 9.70 | lbs. | $4.22 | 10.27 | lbs. | $4.47 |
| | VALUE per year | | $419 | VALUE per year | | $444 |

*figure 4.40*

**Quantifiable Benefits of 34th Street BID Trees - Projected from Proposed Maximum**

| Environmental Benefit | 10-YR GROW-OUT w/MAX: 2009 | | | 20-YR GROW-OUT w/MAX: 2019 | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 348,623 | CF | NC | 438,774 | CF | NC |
| Carbon Storage | 1,068.51 | tons | – | 1,344.82 | tons | – |
| Carbon Sequestration | 23.96 | tons/yr | – | 30.15 | tons/yr | – |
| Ozone Removal | 1,102.86 | lbs. | $3,381 | 1,388.06 | lbs. | $4,255 |
| SO2 Removal | 465.55 | lbs. | $349 | 585.94 | lbs. | $439 |
| NO2 Removal | 1,098.34 | lbs. | $3,367 | 1,382.37 | lbs. | $4,238 |
| PM10 Removal | 1,044.11 | lbs. | $2,137 | 1,314.10 | lbs. | $2,690 |
| CO Removal | 216.96 | lbs. | $94.36 | 273.06 | lbs. | $118.75 |
| | VALUE per year | | $9,328 | VALUE per year | | $11,740 |

*figure 4.41*

**Quantifiable Benefits of Bryant Park BID Trees - Projected from Proposed Maximum**

| Environmental Benefit | 10-YR GROW-OUT w/MAX: 2009 | | | 20-YR GROW-OUT w/MAX: 2019 | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 16,777 | CF | NC | 18,679 | CF | NC |
| Carbon Storage | 51.31 | tons | – | 57.13 | tons | – |
| Carbon Sequestration | 1.15 | tons/yr | – | 1.28 | tons/yr | – |
| Ozone Removal | 52.79 | lbs. | $162 | 58.77 | lbs. | $180 |
| SO2 Removal | 22.39 | lbs. | $17 | 24.93 | lbs. | $19 |
| NO2 Removal | 52.57 | lbs. | $161 | 58.53 | lbs. | $179 |
| PM10 Removal | 50.12 | lbs. | $103 | 55.80 | lbs. | $114 |
| CO Removal | 10.34 | lbs. | $4.50 | 11.52 | lbs. | $5.01 |
| | VALUE per year | | $447 | VALUE per year | | $497 |

*figure 4.42*


# 8TH STREET VILLAGE ALLIANCE BID

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Ms. Honi Klein, Director
**Address:** 8 East 8th Street, New York, NY10003
**Location:** Sixth Avenue (Avenue of the Americas) from West Fourth Street to West 8th Street, West 8th Street from Sixth Avenue (Avenue of the Americas) to Second Avenue and Astor Place from Broadway to St. Marks Place.

## General Site Description

The 8th Street Village Alliance BID was located in the heart of Greenwich Village. With the exception of K-Mart (overlooking the Greenstreets Triangle on Astor Place), the stores were small individual franchises (Bolton's and Au Bon Pair) and independent shops selling clothing, shoes, jeans, books and accessories – scarves, inexpensive jewelry, hats, etc. There was one apartment building with no commercial space. This had trees at the entrance. There were also many food shops selling pizzas, sandwiches and ice cream and a number of small restaurants and coffee shops.

In this area there were mostly low-rise buildings 6 to 8 stories high. The streets were very busy with shoppers, local residents, tourists and students from nearby New York University (NYU), as well as other colleges and law schools. The commercial establishments in the area met the needs of students and residents. (figure 4.43)

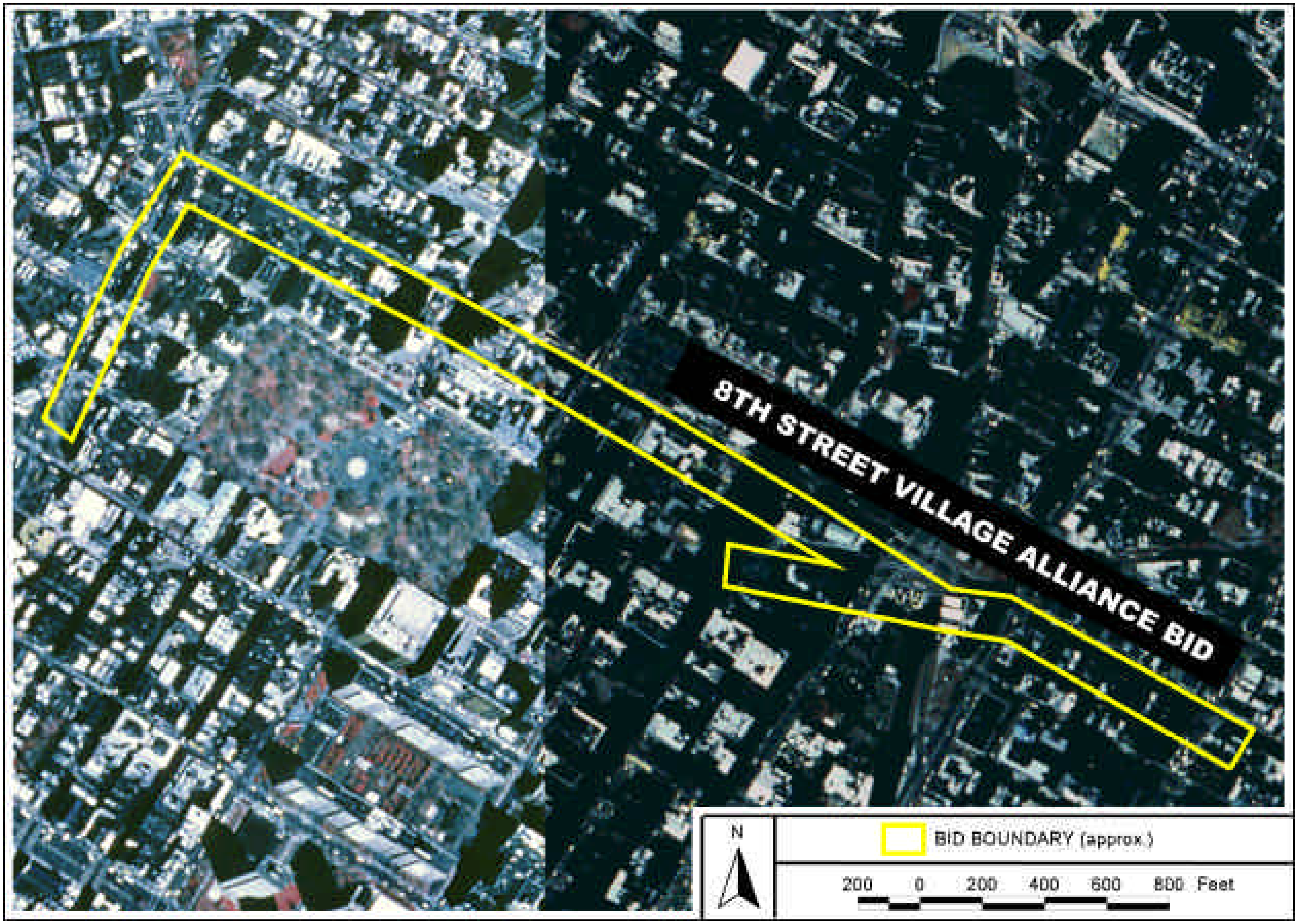
| 8th Street Village Alliance BID Site Facts | |
|---|---|
| Area of Site | 12.02 acres |
| Area of Site | 0.02 square miles |
| Street Length | 1.02 linear miles |
| Tree Canopy Area* | 0.13 acres |
| *Tree Canopy Area of Proposed Trees*** | *0.44 acres* |
| Trees | 52 trees |
| *Potential Trees (Max. Proposed)* | *182 trees* |
| Tree Species | 9 species |
| Tree Density (existing) | 4.33 trees/acre |
| Average Tree Ht | 20.9 feet in Ht |
| Average Tree DBH | 6.9 inch DBH |
| Average Tree Health*** | 2.8 rating |
| Intrinsic Value of On-Site Trees | $36,783 |
| Tree Planting Cost (estimated by management) | $0 /tree |
| Landscape Installation Budget (est. by mgmt.) | $0 /year |
| Landscape Maintenance Cost (est. by mgmt.) | $0 /year |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and included those in sidewalk tree pits, on-site park land and containers.*

** *The collective canopy of the estimated maximum number of individual trees that could be planted throughout the site, including existing and proposed trees in sidewalk tree pits, on-site park land and containers.*

*** *Tree Health was based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excel - lent condition.*

*figure 4.43*




*Map 4.11: 8th Street Village Alliance BID*

## Urban Forest and Landscape Amenities Description

- The 12-acre site had 52 trees of nine different species. Callery pear trees made up 46% of the trees on-site – a large amount for one species. All other species ranged from 2% to 13%.
- Landscape amenities in this BID were constrained by physical obstacles. These included narrow sidewalks, awnings and vaults. The BID director has plans for an overhaul of the streetscape. These plans will result in wider sidewalks, narrower streets, less awnings, continuous tree lawns and extensive street tree plantings.
- Currently the BID does not have a budget or plans for improving the existing landscape. So far the NYC Parks Department did all the plantings at no cost to the BID.
- Existing street trees on the south side of 8th Street contributed to the small town atmosphere of this area. The large number of small and independent businesses in the area enhanced the atmosphere.
- The lack of trees on the north side of the street provided a stark contrast.
- The NYC Parks Department planted new trees on Sixth Avenue following a request from the BID. The BID also submitted a request for the NYC Parks Department to fund the planting of bulbs in Astor Place.
- The 8th street BID did not maintain their landscape directly. They paid the SoHo partnership to maintain the street trees and the Greenstreets Triangle on Astor Place in July and August. During especially dry times, BID personnel cleaned tree pits and watered trees. As the quantity of trees increased, the SoHo partnership would expect increased payment for their landscape maintenance activities. (figure 4.44)

**8th Street Village Alliance BID Tree Statistics**

| Scientific name | Common Name | Count | Percent |
|---|---|---|---|
| Ginkgo biloba | Ginkgo | 1 | 1.9% |
| Picea pungens | Spruce, Colorado | 2 | 3.8% |
| Platanus x acerifolia | Planetree, London | 7 | 13.5% |
| Pyrus calleryana | Pear, Callery | 24 | 46.2% |
| Quercus palustris | Oak, Pin | 1 | 1.9% |
| Quercus phellos | Oak, Willow | 2 | 3.8% |
| Sophora japonica | Pagoda Tree, Japanese | 7 | 13.5% |
| Tilia cordata | Linden, Littleleaf | 6 | 11.5% |
| Zelkova serrulata | Zelkova, Japanese | 2 | 3.8% |
| | **Total Tree Count** | **52** | **100.0%** |

*figure 4.44*

*Greenstreets Triangle*

## Perceived Value of the Urban Forest and Landscape Amenities

**To BID Staff/Management:**

- Ms. Klein acknowledged that street trees were good for business. But enhanced landscaping was linked with the overall streetscape improvements planned for the district in the future. No date had been set for this project and no permits had been granted. The plan included narrowing the street, widening sidewalk and planting trees in tree lawns to increase the number of visitors to the area and encourage them to stay longer.
- Ms. Klein promoted the value of street trees to vendors for their ability to shade and reduce noise. Additionally the aesthetics of trees will be used in the promotion of this area.
- Trees were seen to be psychologically comforting and welcoming, whereas those landscapes without trees were uninviting.
- The tree plantings, as well as the road improvements, would change the ambience of the neighborhood.
- It was also accepted that tree canopies provided noise abatement and improved the quality of life and health in the area. Noise abatement was especially considered in Greenwich Village, which can be raucous.
- Ms. Klein felt that an improved landscape with trees created an attractive environment. She felt this was important to attracting tenants, as well as shoppers.

**To Commercial Tenants/Merchants:**

- According to the BID Director the vendors liked street trees, if they were not too large and did not block their signage. Any new plantings will take this into consideration.
- It was essential to plant trees of the proper size in the right location, so as not to alienate the goodwill of the vendors.
- With a more pedestrian-friendly and green neighborhood, merchants hoped to attract more local customers and tourists, which would translate into more business.

**To Customers:**

- Trees made the area more attractive and inviting. People felt comfortable in the area and stayed longer to shop and browse.
- Trees made the area more attractive to pedestrians and created a human scale, softening the architecture.
- Ms. Klein also felt that the trees contributed cooling shade and affected the health of the visitors in the area.

## Quantified Value of the Urban Forest

This was one of the few sites where UFORE's calculations were higher than CITYgreen's. The 52 trees in the 8th Street BID removed between 15 and 21 pounds of air pollutants valued between $35 and $47 per year. They also emitted about 6 pounds of VOCs and stored approximately 4 tons of carbon. The 0.13-acre tree canopy covered just over 1% of the site and prevented 1,313 cubic feet of stormwater from being discharged. UFORE calculated the actual value of the trees to be $36,783. (figure 4.45)

**Quantifiable Benefits of Trees Derived from Existing Site Data (1999)**
8th Street BID Tree Canopy: 0.13 acres

| Environmental Benefit | UFORE | | CITYgreen | |
|---|---|---|---|---|
| | Removal by Trees | Value | Removal by Trees | Value |
| Stormwater Reduction | – – | NC | 1,313 CF | NC |
| Carbon Storage | 4.48 tons | – | 4.03 tons | – |
| Carbon Sequestration | 0.21 tons/yr | – | 0.09 tons/yr | – |
| Ozone Removal | 5.97 lbs. | $18 | 4.10 lbs. | $13 |
| SO2 Removal | 2.93 lbs. | $2 | 1.80 lbs. | $1 |
| NO2 Removal | 5.27 lbs. | $16 | 4.10 lbs. | $13 |
| PM10 Removal | 4.91 lbs. | $10 | 3.90 lbs. | $8 |
| CO Removal | 1.54 lbs. | $0.67 | 0.80 lbs. | $0.35 |
| | **VALUE per year** $47 | | **VALUE per year** $35 | |

*figure 4.45*

Based on the selected methodology described previously, researchers proposed a maximum of 182 trees for the 8th Street BID. These trees provided a 250% increase in the removal of air pollutants by removing 51 pounds valued at $122 and storing 14 tons of carbon. Additionally stormwater runoff was reduced almost 4,500 cubic feet, rather than 1,300 cubic feet as provided by the existing trees. (figure 4.46)

**Quantifiable Benefits of 8th Street BID Trees - Existing & Proposed Maximum**

| Environmental Benefit | EXISTING SITE DATA : 1999 | | | SITE w/ MAX TREES PLANTED | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 1,313 | CF | NC | 4,596 | CF | NC |
| Carbon Storage | 4.03 | tons | – | 14.11 | tons | – |
| Carbon Sequestration | 0.09 | tons/yr | – | 0.32 | tons/yr | – |
| Ozone Removal | 4.10 | lbs. | $13 | 14.35 | lbs. | $44 |
| SO2 Removal | 1.80 | lbs. | $1 | 6.30 | lbs. | $5 |
| NO2 Removal | 4.10 | lbs. | $13 | 14.35 | lbs. | $44 |
| PM10 Removal | 3.90 | lbs. | $8 | 13.65 | lbs. | $28 |
| CO Removal | 0.80 | lbs. | $0.35 | 2.80 | lbs. | $1.22 |
| | **VALUE per year** | | $35 | **VALUE per year** | | $122 |

*figure 4.46*

## Projected Value of the Urban Forest

The proposed maximum trees were grown out over twenty years from 1999 to 2019. The tree canopy expanded 720% to cover 3.6 acres, approximately 30% of the BID. The green infrastructure removed 424 pounds of air pollutants in 2019 valued at $1,004. Other benefits that were without any monetary values were also attributed to the trees. In 2019 the trees stored 116 tons of carbon sequestered at a rate of 2.6 tons per year and prevented about 38,000 cubic feet of stormwater runoff from being discharged into the city.

Using a linear projection and 1999 monetary values, researchers calculated that 5,875 pounds of air pollutants were removed in the twenty-year period at a value of almost $14,000. Over the same time period about 525,000 cubic feet of runoff was prevented from being discharged into the city's stormwater system. (figure 4.47)

**Quantifiable Benefits of 8th Street BID Trees - Projected from Proposed Maximum**

| Environmental Benefit | 10-YR GROW-OUT w/MAX: 2009 | | | 20-YR GROW-OUT w/MAX: 2019 | | |
|---|---|---|---|---|---|---|
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 31,249 | CF | NC | 37,867 | CF | NC |
| Carbon Storage | 95.91 | tons | – | 116.23 | tons | – |
| Carbon Sequestration | 2.14 | tons/yr | – | 2.60 | tons/yr | – |
| Ozone Removal | 97.58 | lbs. | $299 | 118.24 | lbs. | $362 |
| SO2 Removal | 42.84 | lbs. | $32 | 51.91 | lbs. | $39 |
| NO2 Removal | 97.58 | lbs. | $299 | 118.24 | lbs. | $362 |
| PM10 Removal | 92.82 | lbs. | $190 | 112.48 | lbs. | $230 |
| CO Removal | 19.04 | lbs. | $8.28 | 23.07 | lbs. | $10.03 |
| | **VALUE per year** | | $829 | **VALUE per year** | | $1,004 |

*figure 4.47*

# 47th STREET BID

**Case Study Conducted:** May 1999 to December 1999
**Interviewees:** Terence Clark, Executive Director
**Address:** 580 Fifth Avenue, Room 323, New York, NY 10036
**Location:** 47th Street from Fifth Avenue to Sixth Avenue (Avenue of the Americas) on both the north and south sides of street.

## General Site Description

This BID was only one block long. Apart from one bank on the southwest corner facing Fifth Avenue, the rest of the businesses were independently owned and operated jewelry stores. (figure 4.48)

## Urban Forest and Landscape Amenities Description

- The block had no street trees. Four small spruce trees in containers were placed at the entrance to some stores at the north and south corners of Fifth Avenue. These trees were in poor health and were to be replaced.
- A number of planters were placed very high on lampposts.
- The business owners at the Fifth Avenue end of this BID were responsible for watering the spruce trees placed at the entrance to their businesses every morning and evening.
- Physical constraints such as vaults, street lighting and narrow sidewalks, combined with lack of funding for new plantings resulted in the minimal landscaping in this site.
- BID management hoped that landscaping this BID would distinguish it from similar blocks nearby. Part of the design concept was to consider mitigating the adverse environment during the hot, dry summer. Easy-to-maintain seasonal plantings, including winter arrangements were considered for the future.
- Mr. Clark estimated the maintenance cost at $750 per month per plant. He also estimated the installation of trees in containers to be $600 per tree. and flowers in the pole plantings to be $400 per pole.

| 47th Street BID Site Facts | | |
|---|---|---|
| Area of Site | 6.45 | acres |
| Area of Site | 0.01 | square miles |
| Street Length | 0.20 | linear miles |
| Existing Tree Canopy Area* | 0.00 | acres |
| *Tree Canopy Area of Proposed Trees*** | *0.02* | *acres* |
| Existing Trees | 0 | trees |
| *Potential Trees (Max. Proposed)* | *54* | *trees* |
| *Tree Species (Proposed)* | *9* | *species* |
| *Tree Density (Proposed)* | *8.37* | *trees/acre* |
| *Average Tree Ht (Proposed)* | *15.0* | *feet H* |
| *Average Tree DBH (Proposed)* | *3.0* | *inch DBH* |
| *Average Tree Health*** (Proposed)* | *3.0* | |
| Intrinsic Value of On-Site Trees | NA | |
| Tree Planting Cost (estimated by management) | NA | |
| Landscape Installation Cost (est. by mgmt.) | NA | |
| Landscape Maintenance Cost (est. by mgmt.) | NA | |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and included those in sidewalk tree pits, on-site park land and containers.*

** *The collective canopy of the estimated maximum number of individual trees that could be planted throughout the site, including existing and proposed trees in sidewalk tree pits, on-site park land and containers.*

*** *Tree Health was based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.48*

## Perceived Value of the Urban Forest and Landscape Amenities

**To BID Staff/Management:**

- Mr. Clark felt that other BIDs had a higher level of greening than this part of the city, but his budget constraints did not allow him to increase the number of trees in the area.
- He felt that tree planting and beautification of the BID were a high priority and would set the 47th Street BID apart from other similar city blocks.
- He felt shade trees would provide a canopy that would shade the streets in the hot summer and make the area more inviting to shoppers.

**To Commercial Tenants/Merchants:**

- The business owners at the Fifth Avenue end of this BID appreciated the value of trees, even if they were small potted evergreens.
- The jewelry merchants on this block appreciated the colorful pole plantings and the efforts to distinguish this block from others nearby.
- By making the block more identifiable through attractive low maintenance landscaping, it was hoped that customers would remember the commercial district as a pleasant experience and return to shop again.
- A more appealing shopping area would increase business.

**To Customers:**

- Street trees would bring a human scale to the block and would soften the harsh sterile surroundings.
- Pole plantings provided a splash of color to make their shopping experience more interesting.
- Landscape elements would make the area feel more familiar and comfortable to shoppers from the outer boroughs.
- Street trees would provide shade and make the area cooler on hot summer days.
- If people feel more comfortable in an area, they will stay longer and perhaps return in the future for more shopping.


*Map 4.12: 47th Street BID*

## Quantified Value of the Urban Forest

Because there was no existing green infrastructure in the BID, researchers could not measure or calculate any values.

Based on the selected methodology described previously, 54 trees were determined to be the maximum amount for the 47th Street BID. The proposed trees created a canopy of 0.02 acres, which was less than 1% of the BID. These trees removed 3 pounds of air pollutants valued at $7 and stored 1,580 pounds of carbon. Additionally 257 cubic feet of stormwater runoff was stopped from being discharged into the city. (figure4.49)

| Quantifiable Benefits of 47th Street BID Proposed Trees | | |
|---|---|---|
| Environmental Benefit | SITE w/ MAX TREES PLANTED | |
| | Removal by Trees | Value |
| Stormwater Reduction | 257 CF | NC |
| Carbon Storage | 0.79 tons | – |
| Carbon Sequestration | 0.02 tons/yr | – |
| Ozone Removal | 0.80 lbs. | $2 |
| SO2 Removal | 0.30 lbs. | $0 |
| NO2 Removal | 0.80 lbs. | $2 |
| PM10 Removal | 0.80 lbs. | $2 |
| CO Removal | 0.20 lbs. | $0.09 |
| | VALUE per year | $7 |

*figure 4.49*

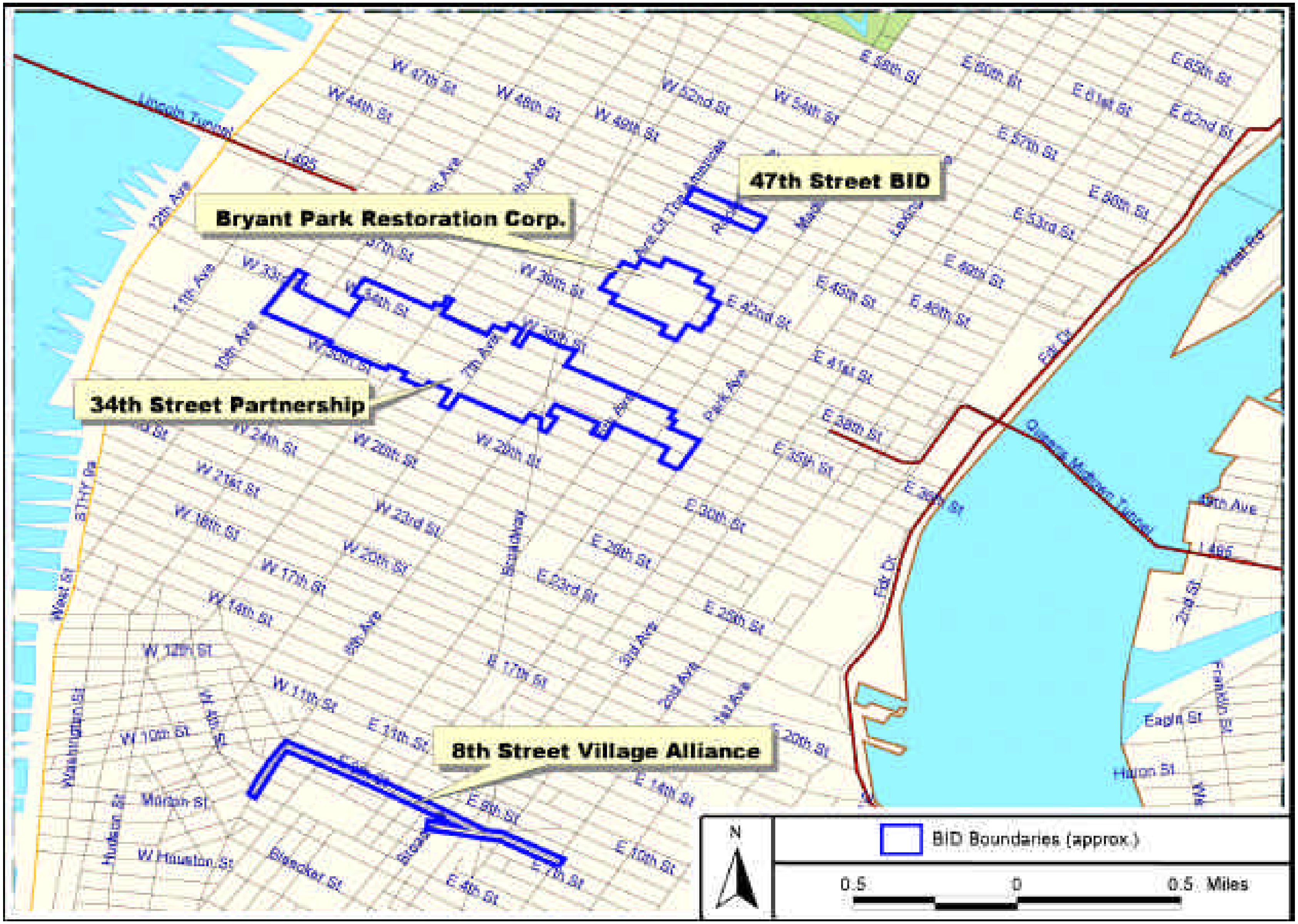
## Projected Value of the Urban Forest

The proposed trees were grown-out over the next two decades. In the first ten years the canopy increased 2,550% to one-half of an acre. In twenty years the canopy increased 3,900% to 0.8 acres – 12% of the BID. These trees removed 94 pounds of air pollutants in 2019 valued at $224, a 3,148% increase from the benefits provided by the proposed trees in 1999. They also provided benefits in 2019 that had no monetary values assigned to them. They stored 26 ton of carbon sequestered at a rate of 0.6 tons per year and prevented the discharge of more than 8,400 cubic feet of stormwater runoff.

A linear progression projected that over twenty years the proposed trees removed more than 1,100 pounds of air pollutants valued at $2,629 at 1999 monetary rates. And approximately 99,000 cubic feet of stormwater runoff was prevented from being discharged into the city's system, which is invaluable to the water quality in the region. (figure 4.50)

| Quantifiable Benefits of 47th Street BID Trees - Projected from Proposed Maximum | | | | |
|---|---|---|---|---|
| Environmental Benefit | 10-YR GROW-OUT w/MAX: 2009 | | 20-YR GROW-OUT w/MAX: 2019 | |
| | Removal by Trees | Value | Removal by Trees | Value |
| Stormwater Reduction | 5,549 CF | NC | 8,429 CF | NC |
| Carbon Storage | 16.95 tons | – | 25.70 tons | – |
| Carbon Sequestration | 0.38 tons/yr | – | 0.58 tons/yr | – |
| Ozone Removal | 17.40 lbs. | $53 | 26.40 lbs. | $81 |
| SO2 Removal | 7.40 lbs. | $6 | 11.20 lbs. | $8 |
| NO2 Removal | 17.40 lbs. | $53 | 26.30 lbs. | $81 |
| PM10 Removal | 16.60 lbs. | $34 | 25.10 lbs. | $51 |
| CO Removal | 3.40 lbs. | $1.48 | 5.20 lbs. | $2.26 |
| | VALUE per year | $148 | VALUE per year | $224 |

*figure 4.50*




*Map 4.13: New York City Business Improvement District Case Studies*

## SUMMARY of NEW YORK CITY BID CASE STUDIES

### General Site Description

By combining all of the data for each of the BIDs, researchers present a better picture of the influence of trees in the city. The four BIDs studied covered about 0.26 square miles of Manhattan and 7.8 linear miles of streets. The 613 trees created a canopy that covered 2.4 acres of the 167-acres that encompassed the four BIDs; about 1.5% of the area. The existing trees consisted of sixteen species and were at a density of 3.7 trees per acre. The average tree was 26 feet tall with a 5-inch diameter and a 2.9 health rating. The intrinsic value of these trees was $224,124. (figure 4.51)

| Summary of NYC BID Case Studies Site Facts | | |
|---|---|---|
| Area of Site | 166.67 | acres |
| Area of Site | 0.26 | square miles |
| Street Length | 7.78 | linear miles |
| Tree Canopy Area* | 2.36 | acres |
| *Tree Canopy Area of Proposed Trees*** | *6.09* | *acres* |
| Trees | 613 | trees |
| *Potential Trees (Max. Proposed)* | *2,115* | *trees* |
| Tree Species | 16 | species |
| Tree Density | 3.68 | trees/acre |
| Average Tree Ht | 25.7 | feet in Ht |
| Average Tree DBH | 5.2 | inch DBH |
| Average Tree Health*** | 2.9 | rating |
| Intrinsic Value of On-Site Trees | $224,124 | |

* *The collective canopy of the individual trees that were planted throughout the site as part of the site's landscaping efforts and included those in sidewalk tree pits, on-site park land and containers.*

** *The collective canopy of the estimated maximum number of individual trees that could be planted throughout the site, including existing and proposed trees in sidewalk tree pits, on-site park land and containers.*

*** *Tree Health was based on the CITYgreen scale of 1 to 5 with 1 as dead/dying and 5 as excellent condition.*

*figure 4.51*

### Quantified Value of the Urban Forest

In 1999 the existing trees in the four BIDs removed 225 pounds of air pollutants at a value of $547. They also stored 19 tons of carbon and reduced the amount of stormwater runoff in the city by 24,760 cubic feet.

Researchers determined 2,115 trees as the maximum to be analyzed for the study. The proposed trees created a canopy of 6 acres, approximately 4% of the combined BID area and 158% larger than the existing canopy. They also removed 717 pounds of air pollutants valued at $1,700 and stored 195 tons of carbon. Additionally 63,740 cubic feet of stormwater runoff was not discharged into the city. (figure 4.52)

| Summary of Quantifiable Benefits of Trees in NYC BIDs - Existing & Proposed Maximum | | | | |
|---|---|---|---|---|
| **Environmental Benefit** | **EXISTING SITE DATA : 1999** | | **SITE w/ MAX TREES PLANTED** | |
| | Removal by Trees | Value | Removal by Trees | Value |
| Stormwater Reduction | 24,759 CF | NC | 63,741 CF | NC |
| Carbon Storage | 19.36 tons | – | 195.28 tons | – |
| Carbon Sequestration | 1.49 tons/yr | – | 4.38 tons/yr | – |
| Ozone Removal | 64.90 lbs. | $199 | 201.15 lbs. | $617 |
| SO2 Removal | 31.51 lbs. | $24 | 85.22 lbs. | $64 |
| NO2 Removal | 58.32 lbs. | $179 | 200.39 lbs. | $614 |
| PM10 Removal | 54.95 lbs. | $112 | 190.69 lbs. | $390 |
| CO Removal | 15.98 lbs. | $33 | 39.55 lbs. | $17.20 |
| | **VALUE per year** | $547 | **VALUE per year** | $1,702 |

*figure 4.52*

## Projected Value of the Urban Forest

The projected twenty-year grow-out scenarios indicated that by 2019 the canopy of the proposed trees expanded 692% to cover 48 acres, 30% of the BID areas. In 2019 this green infrastructure stored 1,544 tons of carbon, prevented the discharge of 503,750 cubic feet of stormwater runoff and removed 5,670 pounds of air pollutants at a 1999 monetary value of $13,466.

Researchers used a linear progression to project that over the twenty year span from 1999 to 2019 the proposed trees removed 77,222 pounds of air pollutants at a value of $183,352 to the city. Additionally they projected that in the same time period the trees reduced the amount of stormwater runoff by 6.9 million cubic feet an invaluable benefit to the region's water quality. (figure 4.53)

| Summary of Quantifiable Benefits of Trees in NYC BIDs - Projected from Proposed Maximum | | | | | | |
|---|---|---|---|---|---|---|
| Environmental Benefit | 10-YR GROW-OUT w/MAX: 2009 | | | 20-YR GROW-OUT w/MAX: 2019 | | |
| | Removal by Trees | | Value | Removal by Trees | | Value |
| Stormwater Reduction | 402,198 | CF | NC | 503,749 | CF | NC |
| Carbon Storage | 1,232.68 | tons | – | 1,543.88 | tons | – |
| Carbon Sequestration | 27.63 | tons/yr | – | 34.61 | tons/yr | – |
| Ozone Removal | 1,270.63 | lbs. | $3,895 | 1,591.47 | lbs. | $4,879 |
| SO2 Removal | 538.18 | lbs. | $403 | 673.98 | lbs. | $505 |
| NO2 Removal | 1,265.89 | lbs. | $3,881 | 1,585.44 | lbs. | $4,860 |
| PM10 Removal | 1,203.65 | lbs. | $2,463 | 1,507.48 | lbs. | $3,085 |
| CO Removal | 249.74 | lbs. | $108.61 | 312.85 | lbs. | $136.06 |
| | **VALUE per year** | | $10,751 | **VALUE per year** | | $13,466 |

*figure 4.53*

## Downtown Business Improvement District Case Study Findings

In New York City landscaping and tree planting efforts were more likely to occur in areas that had organized leadership. In residential areas block or neighborhood associations usually took the lead in greening efforts and mobilizing neighbors to request street trees from the NYC Parks Department or to plant flowers and clean tree pits. Individual merchants and landlords outside of an organized BID were less likely to invest in planning or planting. In commercial areas where BIDs were present, landscaping efforts were considered a part of the BID's infrastructure. Budget constraints effected the amount of landscaping in a BID, but most BID directors and staff performed some planting and care with their restricted funds.

Some BIDs assisted with tree maintenance, if landlords or tenants did planting in the BID. This assistance was often the catalyst that encouraged store owners to support landscaping and tree planting. The removal of the pressure to maintain the trees increased the number of merchants that requested trees near their storefronts.

When budgets were low or did not exist, BID directors looked to enhance their environment through collaborations and partnerships. The NYC Parks and Recreation Department's tree-planting program allowed BIDs to obtain trees at no cost. Although the City Charter required the city to maintain all street and park trees, historically they could not. BIDs worked with their members and neighbors for maintenance assistance.

The above projected summaries indicated that the green infrastructure could provide many more benefits for the public good in New York, if more trees were planted. The quantitative analysis indicated that the addition of 1,500 trees along 8 miles of streets would remove more than 77,000 pounds of air pollutants and reduce stormwater runoff by 6.9 million cubic feet over twenty years.

All of the BID directors agreed that landscaping was essential to improving their district and that a well-planned and well-maintained landscape was worth the investment. They were usually aware of the landscaping levels in neighboring districts and sought to emulate these landscapes or exceed their levels of green. They also acknowledged that street trees, park trees and other landscape elements increased property values and increased foot traffic, which provided economic benefits to the BID. They also felt that landscaping was of equal importance to security and sanitation when effecting economic improvements. And they recognized that a healthy green infrastructure in the BID created a human scale, made the BID more attractive and comfortable and invited shoppers to linger longer and return to the area, which translated into increased sales and better business.

In addition to the BIDs studied in depth as case studies, the initial BID survey provided similar information about the perceived value of green infrastructure in New York City BIDs. The responses to the NYC BID survey represented a diversity of neighborhoods and demographic profiles. Ninety-five percent of the responding BIDs had horticultural elements. The most common landscape element reported by 75% of respondents was trees in sidewalk pits. The least common landscape elements were flowerpots on poles. 80% felt that landscape elements served an important purpose in the area, but only 30% of the respondents employed a staff person whose main responsibility was to oversee the landscape elements on site. Sixty percent of the BIDs had commercial and retail members who requested the planting of trees.

Unfortunately, planting trees in NYC, as in other cities, was not always easy. Many physical and/or mechanical circumstances limited tree-planting efforts. Vaults, narrow sidewalks, underground utilities, overhead utility wires, street lighting and elevated subway lines limited the number and type of trees that could have been effectively used in many of the districts. Eighty percent of the respondents maintained that these physical hindrances were the reasons they did not do more tree planting. Additionally the Times Square BID, as well as an industrial park BID in Brooklyn, felt that trees were inappropriate in their districts due to the unique nature of their areas, which precluded their potential to plant trees.

Half of the respondents noticed landscape elements and/or horticultural activities in other areas of the City that they wanted to incorporate in their districts. But landscape budgets for trees, tree pits and other horticultural elements varied from $1,000 to $60,000 per year. Half of the respondents spent less than $1,000 per year, 35% spent between $1,000 and $20,000, and 15% spent between $20,000 and $60,000. Sixty percent of the respondents would maintain the landscaping budget at 1999 levels. Thirty five percent predicted an increased budget line for the landscape in 2000, while only 5% planned to decrease their horticultural budget.

The BID survey clearly showed that the BIDs and their members embraced greening initiatives in a variety of ways including:

- Unique tree pit guards and labels
- Plantings in tree pits
- Trees in containers (especially in areas that had extensive vaults under their sidewalks)
- Hanging flower baskets
- Flower baskets on poles
- Flowers and/or shrubs in large containers

The survey responses as well as the interviews indicated that trees and other landscape elements were perceived as valuable to increasing the use of a BID by shoppers, office workers and tourists. Aesthetics, color, shade, human scale and softening the harsh city surroundings were identified as the reasons for planting trees in the BIDs. Directors of the BIDs were familiar with the benefits that trees provided that went unnoticed – improving air quality, mitigating noise and decreasing stormwater runoff. They also understood the importance of maintenance in growing healthier, mature trees that provided more benefits. Therein was the problem. Many of the BIDs lacked the funding to maintain the investments they had made in their BID's green infrastructure.

Greening preferences were important to all the responding BIDs, but their interests did not necessarily translate to an appropriate budget response. Despite this conundrum, BIDs funded their belief in greening programs. More than 90% of them felt that their investments in the green infrastructure and their planting and care initiatives were "good for business".

### Local Case Study Conclusions

The case studies successfully demonstrated that trees and forestland on commercial sites provided many valuable benefits to the region that went unnoticed by the users of the BIDs – air pollution removal, stormwater runoff reduction and carbon sequestration. These invaluable benefits contributed to the quality of life in the region – noise abatement, better air quality, improved water quality of our water bodies and watersheds. The associated monetary values were also indicative of the overlooked benefits the trees provided to New York City, as well as New Jersey communities.

The following general observations and conclusions resulted from reviewing the results of CITYgreen and UFORE analyses, the results of the in-depth anecdotal interviews and the results of the BID survey.

- A general review of the case study analyses results led to the realization that the planting or maintenance of an individual tree was not cost-justified on these benefits alone. Indeed most of the quantified benefits of trees were for public goods, not directly related to the economic benefit of the owners or managers of the sites.
- Comparison of the air pollution mitigation results provided by CITYgreen and UFORE applied to identical site studies showed relatively good agreement. This finding supported the use of CITYgreen to provide reasonable estimates of air pollution with a relatively low expense of field time and modeling effort. However there often was a wide margin of disagreement between the two models for the amount of carbon stored by the trees. And there was no comparison for the validity of the stormwater calculations.
- Direct measurement of the cooling effects of tree shading and evapo-transpirational cooling in landscaped areas proved to be about one degree centigrade per 10% tree canopy cover. While no studies of such effects in parking lots were identified, USFS researchers suggested that such cooling effects were even more pronounced. The cooling and shading in parking lots was believed to have benefits related to human comfort (reduced thermal stress) and reduced VOC losses (resting losses) from vehicles. NASA researchers study-

ing thermographic satellite imagery measured significant cooling effects as a result of landscape and street trees in the city environment. These studies correlated the effect tree planting had in cooling heat islands, which also reduced smog formation and resulted in air quality improvements on a citywide scale.

- Literature review showed other significant and measurable benefits attributed to urban forests and trees. Of particular note were the cooling and microclimate effects of trees in the urban environment. The cooling effects caused by tree-shading on adjacent structures was recognized and included in the CITYgreen modeling program, however the model's limitations made it impossible to use for the commercial sites in this study.

- The results of the local case study analyses demonstrated the direct correlation between the level of benefits and the total canopy area of both landscape trees and forested areas on commercial sites.

- The grow-out scenarios indicated in the Lawrence Center, Courtyard by Marriott and 47th Street BID sites – sites with newly planted trees – demonstrated the dramatic increase in benefits in the first few decades as young trees grew and matured.

- Forested areas with nearly 100% canopy cover provided the highest level of air pollution and stormwater mitigation benefits to a particular site or region. The relatively modest forest patches maintained on the South Brunswick Square Mall, Lawrence Center and Bryant Park BID sites contributed the majority of the benefits that the site provided. Thus it was evident that the preservation of forested areas, as well as long-term maintenance to sustain landscape and street trees yielded the greatest overall benefits.

In addition to the quantitative analysis the case studies demonstrated that the people managing commercial sites understood the value of trees and landscaping as it related to their commercial success or failure. They recognized that the amount, type and condition of green infrastructure on a site could be positive or negative. They affirmed that trees and landscaping attracted customers and tenants/merchants, helped them compete with neighboring establishments, provided a first and lasting impression with customers and guests, differentiated them from similar establishments, defined traffic patterns on a site more readily, provided a human scale and created more comfortable surroundings that encouraged people to stay longer and return to the site. Additionally they felt that people associated well-maintained landscape elements to a well-maintained business. In the city physical constraints (mechanical and physical barriers) influenced the amount of greening that could be done. They were also concerned with vandalism and theft when making their plans to invest in greening. Although commercial managers in the cities and suburbs acknowledged the costs for installation and maintenance, they felt the benefits outweighed the costs.

Very rarely did management make decisions about commercial landscape plans. They relied on professional landscape architects and engineers to create plans that would fit the site and emulate or exceed the landscape of their competitors or neighbors. Municipal influence varied with the standards set by the ordinances, as well as the involvement and commitment of local decision-makers – planning staff, elected officials and planning/zoning boards. Commercial establishments abided by local ordinances, usually without question, to maintain good relationships within the city – part of doing good business. The green infrastructure was perceived as a good investment on commercial sites.

# APPENDICES

## Commercial District Image-Based Valuation Survey

### Demographic Information

1. What is your home zip code?

2. What municipality do you live in?

3. Regarding your education, have you:

| | | |
|---|---|---|
| • graduated from high school or received a GED? | YES | NO |
| • attended some college, but did not receive a degree? | YES | NO |
| • received a college degree? | YES | NO |

4. Which of the following best describes your household's gross annual income?

| | | |
|---|---|---|
| • less than $40,000 | YES | NO |
| • between $40,000 and $90,000 | YES | NO |
| • greater than $90,000 | YES | NO |

5. Which best describes your occupation?

___Employed full-time ___Employed part-time ___Consultant

___Full-time student ___Part-time student ___Other

### Travel behavior

6. Place an X next to the statement that best reflects how many minutes you must travel from your home to get to your regular grocery store?

___ Less than 5 mins.
___ From 5 to 15 mins.
___ From 15 to 30 mins.
___ More the 30 mins.

7. How many times do you shop there each week? ________

8. Place an X next to the statement that best reflects how many minutes you must travel from your home to get to your favorite shopping mall?

___ Less than 5 mins.
___ From 5 to 15 mins.
___ From 15 to 30 mins.
___ More the 30 mins.

9. How many times do you shop there each month? ________

### Commercial Site Amenities

10. From the following list of amenities, circle YES to indicate that you care if the places where you shop have these features or circle NO if you do not care.

a. Interesting architectural style Yes No
b. Holiday lighting & decorations Yes No
c. Interior landscaping (planters...) Yes No
d. Artwork (sculptures, fountains…) Yes No
e. Skylights/Natural Lighting Yes No
f. Exterior landscaping (trees, grass…) Yes No
g. Shaded parking Yes No
h. Special events (shows, music...) Yes No

10. From the above list (a – h), select the top two amenities you would prefer to have at malls where you shop. ___________

11. From the above list (a – h), select the two features you are the least interested in having at malls where you shop. ___________

## Commercial District Site Survey
## Image-Based Preference

Compare the sites in the following pairs of slides. Assume that they are the same distance from your home and that you could purchase the same items at the same price at either site. Indicate which site you would prefer to go to shop by circling A or B. If you did not want to shop at your least preferred site, how many more minutes would you be willing to travel to shop at the site you preferred the most. Place an X next to the selected time.

Downtown Shopping Area

1. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

2. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

3. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

4. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

Suburban Strip Shopping Center

5. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

6. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

7. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

8. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

Suburban Shopping Malls

9. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

10. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

11. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

12. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

13. A B ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

Compare the sites in the following groups of slides. Assume that they are the same distance from your home and that you could purchase the same items at the same price at either site. Circle the letter that indicates where you would prefer to go to shop. Then circle the letter of the site where you would least prefer to shop. If you did not want to shop at your least preferred site, how many more minutes would you be willing to travel to shop at the site you preferred the most. Place an X next to the selected time.

## Shopping Preferences

14. Most Favorite — A B / C D
Least Favorite — A B / C D
Willingness to Travel — ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

15. Most Favorite — A B / C D
Least Favorite — A B / C D
Willingness to Travel — ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

16. Most Favorite — A B / C D
Least Favorite — A B / C D
Willingness to Travel — ___ < 5 min. ___ 5-15 min. ___ 15-30 mins. ___ > 30 mins.

## Parking Lots

Compare the four parking lots in the following slides and answer the following questions.

17. Most Favorite — A B C D

Least Favorite — A B C D

Willingness to Travel

| | |
|---|---|
| ___ < 5 min. | ___ 5-15 min. |
| ___ 15-30 mins. | ___ > 30 mins. |

Indicate your opinion of the relationship between parking lots and commercial business. For each of the following types of businesses, indicate which parking lot image (A– E) could be associated with it.

| **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|
| Discount Store | Discount Store | Discount Store | Discount Store | Discount Store |
| Upscale Mall | Upscale Mall | Upscale Mall | Upscale Mall | Upscale Mall |
| Grocery Store | Grocery Store | Grocery Store | Grocery Store | Grocery Store |
| Strip Mall | Strip Mall | Strip Mall | Strip Mall | Strip Mall |
| Office Park | Office Park | Office Park | Office Park | Office Park |
| Restaurant | Restaurant | Restaurant | Restaurant | Restaurant |
| Outlet Center | Outlet Center | Outlet Center | Outlet Center | Outlet Center |
| Hotel | Hotel | Hotel | Hotel | Hotel |

**Note: The format of this 3-page survey was altered to fit the format of this book.**

## IMAGE-BASED VALUATION SURVEY SCRIPT (for interviewer)

Thank you for participating in this survey. Over the next 20 minutes or so, I will be asking you some questions about how you feel towards various types of shopping districts. I represent an independent group that is not affiliated with any shopping center or any retailers, so please feel free to express your honest opinions. We are handing out a form for recording your answers to the survey. The first part contains general questions about you and will be useful for determining the demographics of those who participated in the survey. Your answers will not be linked directly to you or used for anything other than this survey. Please try to answer the questions as accurately as possible in the next 5 minutes. When everyone is done we will proceed with the survey.

*[5 minute break to complete form unless they completed it as they came in.]*

Over the next 15 minutes I will show you images depicting various types of retail shopping districts. For each pair of images, I will ask you about where you would prefer to shop and your willingness to travel further to the site you prefer. You should assume that you can purchase the same products at the same price at both sites. All brand names, logos, signs, and store names have been removed from the slides, so as not to bias your selection.

For example, after reviewing a pair of slides, you may prefer to shop at Site A more than Site B. And you might be willing to travel 15 minutes further to shop at Place A, which is your favorite of the two places. *[Image in left column is left slide projector & image in right column is right slide projector.]*

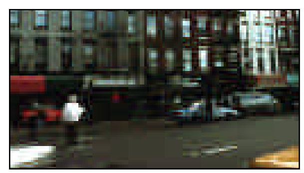
## Series 1

This first series of photographs depicts various downtown commercial districts. For each pair of images, I will ask you to select which one of the two you would prefer to go to shop. Circle the letter that represents the slide you prefer. Then I will ask you how many more minutes you would be willing to travel in order to shop at the site that you prefer the most. Place an X next to the most appropriate response: less than 5 minutes, between 5 and 15 minutes, between 15 and 30 minutes, or greater than 30 minutes. If you are not willing to travel, do not make any time selection. Are there any questions? *[PAUSE…]* Let's begin.

No. 1: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

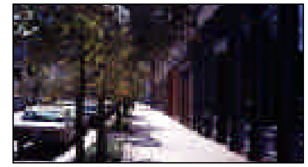
If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?

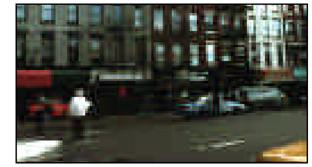

1A


1B

No. 2: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

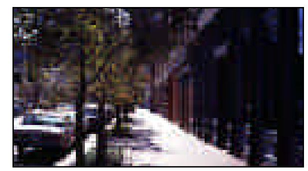
If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?


2A


2B

No. 3: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

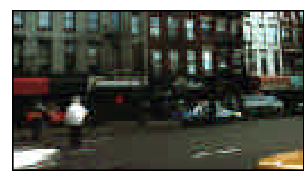
If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer the most?

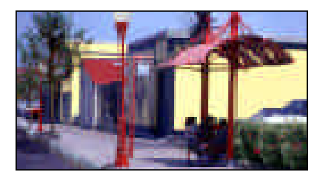

3A


3B

No. 4: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer the most?


4A

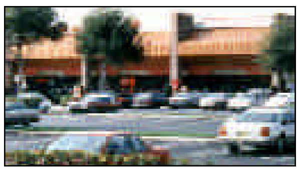

4B

## Series 2

This next series of images depicts suburban strip shopping centers, where each of the stores have an outside entrance from the parking area. You complete the form in the same way as you did for the first series. Any questions? *[PAUSE…]* Let's begin.

No. 5: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

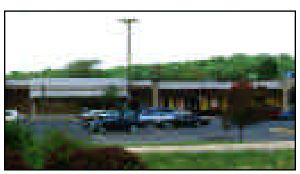
If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?


5A


5B

No. 6: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?


6A


6B

No. 7: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

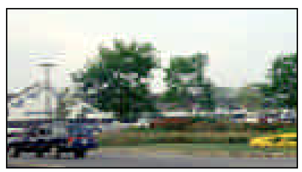
If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer the most?

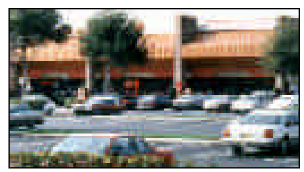

7A


7B

No. 8: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer the most?


8A


8B

## Series 3

This next series of images depicts suburban shopping malls, where there are a few main entrances to the mall or stores from the parking area, but you can enter all the stores from an interior walkway. You complete the form in the same way as you did for the first series. Any questions? *[PAUSE]* Let's begin.

No. 9: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

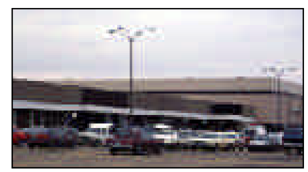
If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?


9A


9B

No. 10: Assuming that both sites are the same distance from your home and that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

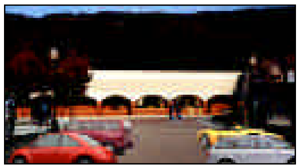
If you did not want to shop at your least favorite of the two, how many more minutes would you be willing to travel to shop at the place you prefer the most?


10A


10B

No. 11: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer?



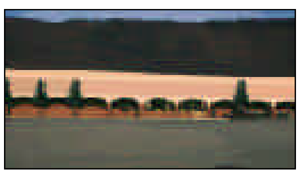
11A

11B

No. 12: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer?

12A



12B

No. 13: Assuming that you could purchase the same products at the same price at either site, would you prefer to shop at Place A or Place B? Place A or Place B?

If you did not want to shop at your least favorite, how many more minutes would you be willing to travel to shop at the place you prefer?

13A

13B

## Series 4

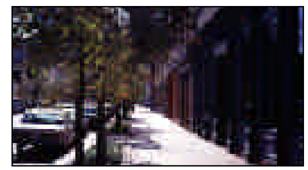
Next, you will be shown a group of four images. For each group, I will ask you to indicate where you would most like to shop and where you would least like to shop. You will still assume that you can purchase the same products at the same price at any of these stores. Then I will ask your willingness to travel to shop at your favorite of the four rather than the one you like the least. Let's begin.

*[NOTE: There are two images on each slide. To make it under - standable as to which is which, cover one projector lens and announce "A on the top B on the bottom" for the visible slide; then cover other lens and explain "C on the top D on the bot - tom". Then show all four slides at same time for comparison. Repeat one lens at a time, then show all four again before ask - ing willingness to travel or proceeding to next images.]*

No. 14: Assuming that you can purchase the same products at the same price at any of the four places, which would you pre- fer to go to shop? A, B, C or D? Circle the letter indicating your response under the column "most favorite". A, B, C or D?

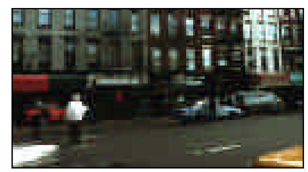
Of the same images, which is your least favorite? A, B, C or D? Circle the letter indicating your response under the column "least favorite. A, B, C or D?

And finally, if you do not want to shop at your least favorite site, how many more minutes would you be willing to travel in order to shop at your most favorite site.

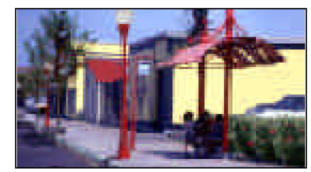


14A

14C



14B



14D

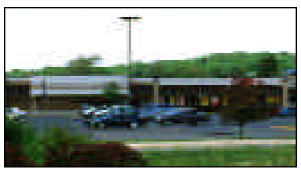
No. 15: Assuming that you can purchase the same products at the same price at any of the four places, which would you prefer to go to shop? A, B, C or D? Circle the letter indicating your response under the column “most favorite”. A, B, C or D?

Of the same images, which is your least favorite? A, B, C or D? Circle the letter indicating your response under the column “least favorite. A, B, C or D?

And finally, if you do not want to shop at your least favorite site, how many more minutes would you be willing to travel in order to shop at your most favorite site.


15A


15C


15B


15D

No. 16: Assuming that you can purchase the same products at the same price at any of the four places, which would you prefer to go to shop? A, B, C or D? Circle the letter indicating your response under the column “most favorite”. A, B, C or D?

Of the same images, which is your least favorite? A, B, C or D? Circle the letter indicating your response under the column “least favorite. A, B, C or D?

And finally, if you do not want to shop at your least favorite site, how many more minutes would you be willing to travel in order to shop at your most favorite site.


16A


16C


16B


16D

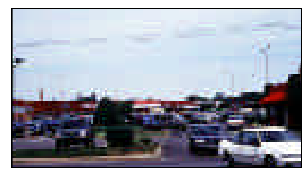
## Series 5

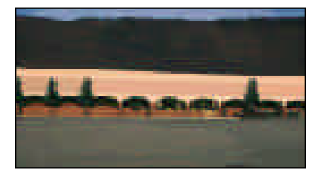
In this final series, you will see parking lots of four shopping areas. Once again assume that you can purchase the same products at the same price at any of the sites.

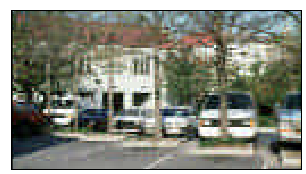
No. 17: Indicate which of the four you would prefer as the parking area of the place where you shop by circling A, B, C or D under Most Favorite. Once again select your most favorite.

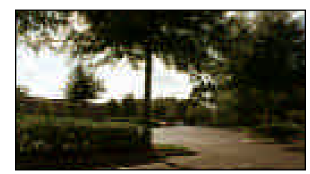
Now indicate which of the four is your least preferred parking lot by circling A, B, C, or D under least favorite. You are now selecting your least favorite parking lot.

How many minutes would you be willing to travel to go to the shopping area with the nicer parking lot, if the stores and merchandise were the same.


17A


17B


17C


17D

No. 18: The final question assumes that you could guess the type of commercial establishments inside the buildings adjacent to a parking lot, just by looking at the design and layout of the parking lot. Please give us your opinion on what type of establishment would be associated with the following parking areas. I will show you a slide and tell you the letter that pertains to that slide. For example, I will show you Slide A. Then look at the types of commercial areas listed in question 18 and guess which commercial area might have a parking lot like that of Slide A. I will read aloud each type of commercial area as each slide is being shown. Circle the letter A for any of the commercial areas that you think could be related to that parking area. Then we will proceed to Slide B. There may be more than one or no letters circled for each commercial area shown. There are no right or wrong answers. Any questions? *[PAUSE]* Let's begin.

A - Discount Stores. An Upscale Mall. A Grocery Store. A Suburban Strip Mall. An Office Park. A Restaurant. An Outlet Shopping Center. A Hotel - A

B - Discount Stores. An Upscale Mall. A Grocery Store. A Suburban Strip Mall. An Office Park. A Restaurant. An Outlet Shopping Center. A Hotel - B

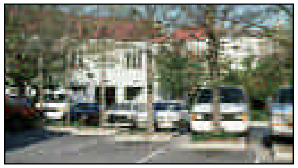
C - Discount Stores. An Upscale Mall. A Grocery Store. A Suburban Strip Mall. An Office Park. A Restaurant. An Outlet Shopping Center. A Hotel - C

D - Discount Stores. An Upscale Mall. A Grocery Store. A Suburban Strip Mall. An Office Park. A Restaurant. An Outlet Shopping Center. A Hotel - D

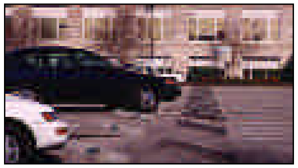
E - Discount Stores. An Upscale Mall. A Grocery Store. A Suburban Strip Mall. An Office Park. A Restaurant. An Outlet Shopping Center. A Hotel - E


18A


18B


18C


18D


18E

**Wrap-Up**

Thank you for participating in this survey. We appreciate that you could take the time to help us in our research study. As we collect your surveys, I would like to tell you about our research project and our organization, Trees New Jersey. Trees New Jersey is a statewide nonprofit organization. We cultivate greener communities through education and volunteer efforts. Our programs encourage partnerships, instill a sense of community and grow healthier community forests – the forests where we live. This survey is one component of a research study to look at the green infrastructure within commercial districts and to determine the value that the users, developers, owners, vendors, and local decision-makers place on the green infrastructure. Additionally we are running a scientific analysis of BID districts in NYC and commercial sites along the Route 1 corridor from Trenton to New Brunswick. We are interpreting the trends in developing areas for the removal of forested areas and how that affects stormwater runoff. We selected a few sites for case studies and are determining the dollar value of green infrastructure using existing models through GIS programs that measure carbon sequestration, stormwater runoff, and energy savings. If anyone is interested in the results of this research project, please place an X next to your name and address on the sign-in sheet. At this time we would like to offer you time to give us your opinions on commercial development in the state or on the survey in particular. *[RECORD ANSWERS]* Thank you and have a good evening/day.

# COMMERCIAL DISTRICT SURVEY SUMMARIZED DATA
## Respondents' Background Information

## PART A: Respondents' Background Information

**• DEMOGRAPHICS**

**1/2. Residence by zip code:**

14 New Jersey locations and 15 New York locations (14 in 1 of the 5 NYC boroughs)
07016, 08505, 08534, 08536, 08540, 08550, 08554, 08609, 08618, 08620, 08690, 08759, 08820, 08901
10012, 10013, 10017, 10022, 10025, 10027, 10128, 10312, 10463, 11201, 11205, 11209, 11212, 11215, 12603

**3. Education Level:**

| not a HS grad | HS grad | college no degree | college grad | |
|---|---|---|---|---|
| 2 | 7 | 8 | 37 | *54 responses* |
| *4%* | *13%* | *15%* | *69%* | |

**MODE= College Graduate**

**4. Gross Annual Household Income:**

| <$40K | $40K to $90K | > $90K | No reply | |
|---|---|---|---|---|
| 9 | 25 | 15 | 5 | *54 responses* |
| *17%* | *46%* | *28%* | *9%* | |

**MODE= $40,000 to $90,000**

**5. Employment:**

| FullTime Job | PartTime Job | FullTime Student | PartTime Student | Consultant | Other | |
|---|---|---|---|---|---|---|
| 35 | 5 | 6 | 0 | 4 | 4 | *54 responses* |
| *65%* | *9%* | *11%* | *0%* | *7%* | *7%* | |

**MODE= Full Time Job**

**• TRAVEL BEHAVIOR**

**6. How many minutes to travel from home to grocery store?**

| minutes | 0 | < 5 | 5 - 15 | 15-30 | < 30 | |
|---|---|---|---|---|---|---|
| count | 0 | 28 | 23 | 3 | 0 | *54 responses* |
| | *0%* | *52%* | *43%* | *6%* | *0%* | |

**MODE = < 5 minutes**

**7. Number of visits to grocery store per week:**

| value | 0.25 | 0.75 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 5 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| count | 1 | 1 | 24 | 2 | 8 | 3 | 7 | 2 | 1 | 2 | *51* | *responses* |
| product | 0.25 | 0.75 | 24 | 3 | 16 | 7.5 | 21 | 7 | 5 | 14 | 98.5 | total value |

**AVERAGE= 1.9 trips per week**
**MEDIAN= 2.25 trips per week**
**MODE= 1 trips per week**
**DATA=** 0.25,0.75,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1.5,1.5,2,2,2,2,2,2,2,2,2.5,2.5,2.5,3,3,3,3,3,3,3,3.5,3.5,5,7,7
**No response= 3**

**8. How many minutes to travel from home to favorite shopping mall?**

| minutes | 0 | < 5 | 5 - 15 | 15-30 | < 30 | | |
|---|---|---|---|---|---|---|---|
| count | 5 | 1 | 13 | 27 | 8 | *54* | *responses* |
| | *9%* | *2%* | *24%* | *50%* | *15%* | | |

**MODE = 15-30 minutes**

**9. Number of visits to shopping mall per month:**

| value | *0.5* | *0* | *1* | *1.5* | *2* | *2.5* | *3* | *4* | *4.5* | *5* | *8* | *12* | *15* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| count | 1 | 4 | 19 | 3 | 9 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | *50* | *responses* |
| product | 0.5 | 0 | 19 | 4.5 | 18 | 5 | 9 | 8 | 4.5 | 10 | 8 | 24 | 15 | 125.5 | total value |

**AVERAGE= 2.5 trips per month**
**MEDIAN= 3 trips per month**
**MODE= 1 trips per month**
**DATA=** 0.5,0,0,0,0,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1.5,1.5,1.5,2,2,2,2,2,2,2,2,2,2.5,2.5,3,3,3,4,4,4.5,5,5,8,12,12,15
**No response= 4**

• **SITE AMENITIES**

**10. Commercial Site Amenities:**

| | (Desire On-site) YES | (Don't Care if Onsite) NO | no reply | total responses | Preference percent |
|---|---|---|---|---|---|
| Interesting Architectural Style: | 41 | 12 | 1 | 54 | 76% |
| Holiday Lights & Decorations: | 31 | 21 | 2 | 54 | 57% |
| Interior Landscaping: | 43 | 8 | 3 | 54 | 80% |
| Artwork/Sculpture: | 38 | 14 | 2 | 54 | 70% |
| Skylights/Natural Lighting: | 47 | 4 | 3 | 54 | 87% |
| Exterior Landscaping: | 46 | 6 | 2 | 54 | 85% |
| Shaded Parking Areas: | 40 | 13 | 1 | 54 | 74% |
| Special Events: | 18 | 34 | 2 | 54 | 33% |

**Desirable Features ranked in order:** (with 1 being most desirable)
#1-Skylights/Natural Lighting, #2-Exterior Landscaping, #3-Interior Landscaping, #4-Interesting Architectural Style, #5-Shaded Parking, #6 Artwork/sculpture, #7-Holiday Lights/Decorations, #8-Special Events

**No care, if amenity present:** (with 1 being most often listed as NOT a desirable feature)
#1-Special Events, #2-Holiday Lights/Decorations, #3Artwork, #4-Shaded Parking, #5-Interesting Architecture, #6-Interior Landscaping, #7-Exterior Landscaping, #8-Skylights/Natural Lighting

**11. Most preferred amenities at shopping malls (when selecting top 2):**

| | |
|---|---|
| Interesting Architectural Style: | 20 |
| Holiday Lights & Decorations: | 4 |
| Interior Landscaping: | 15 |
| Artwork/Sculpture: | 10 |
| Skylights/Natural Lighting: | 14 |
| Exterior Landscaping: | 23 |
| Shaded Parking Areas: | 12 |
| Special Events: | 4 |

**Top 2 Amenities: #1-Exterior Landscaping, #2-Interesting Architectural Style**

**12: Least Preferred amenities at shopping malls (when selecting worst 2):**

| | |
|---|---|
| Interesting Architectural Style: | 5 |
| Holiday Lights & Decorations: | 20 |
| Interior Landscaping: | 4 |
| Artwork/Sculpture: | 12 |
| Skylights/Natural Lighting: | 5 |
| Exterior Landscaping: | 1 |
| Shaded Parking Areas: | 14 |
| Special Events: | 37 |

**Bottom 2 Amenities: #8-Special Events, #7-Holiday Lights & Decorations**

# PART B: Image-Based Preferences of Respondents

## • DOWNTOWN SHOPPING AREAS

| | A | B | no response | | no response | <5min | 5-15 | 15-30 | >30 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Preferred Site | 9 | **45** | | WTP in Travel | 2 | 10 | **31** | 6 | 5 | 54 |
| 2. Preferred Site | **45** | 9 | | WTP in Travel | 2 | 16 | **29** | 7 | 0 | 54 |
| 3. Preferred Site | **22** | **32** | | WTP in Travel | 2 | 17 | **30** | 5 | 0 | 54 |
| 4. Preferred Site | 35 | **18** | 1 | WTP in Travel | 7 | 17 | **26** | 4 | 0 | 54 |
| | | | | | | | | | | 0 |
| | | | | | | | | | | 0 |

## • SUBURBAN STRIP SHOPPING CENTERS

| | A | B | no response | | no response | <5min | 5-15 | 15-30 | >30 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 5. Preferred Site | **43** | 8 | 3 | WTP in Travel | 4 | 20 | **24** | 5 | 1 | 54 |
| 6. Preferred Site | **41** | 13 | | WTP in Travel | 2 | **24** | **24** | 3 | 1 | 54 |
| 7. Preferred Site | **50** | 4 | | WTP in Travel | 2 | 18 | **29** | 5 | 0 | 54 |
| 8. Preferred Site | **30** | **22** | 2 | WTP in Travel | 5 | 18 | **25** | 5 | 1 | 54 |
| | | | | | | | | | | 0 |
| | | | | | | | | | | 0 |

## • SUBURBAN SHOPPING MALLS

| | A | B | no response | | no response | <5min | 5-15 | 15-30 | >30 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9. Preferred Site | 10 | **43** | 1 | WTP in Travel | 2 | 17 | **30** | 5 | 0 | 54 |
| 10. Preferred Site | 3 | **51** | | WTP in Travel | 2 | 11 | **30** | 11 | 0 | 54 |
| 11. Preferred Site | **45** | 8 | 1 | WTP in Travel | 5 | **23** | 20 | 5 | 1 | 54 |
| 12. Preferred Site | **48** | 6 | | WTP in Travel | 2 | 17 | **27** | 8 | 0 | 54 |
| 13. Preferred Site | **12** | **42** | | WTP in Travel | 5 | **22** | 21 | 6 | 0 | 54 |

NOTE: Numbers above in boldface indicate the greener image of the pairs.

Note: Numbers above in boldface are the most frequent amounts of time.

## • SHOPPING PREFERENCES

| | A | B | C | D | | no response | <5min | 5-15 | 15-30 | >30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 14. Downtown Shopping Areas | | | | | | | | | | | |
| Most Favorite | **22** | 4 | **27** | *1* | WTP.travel | 1 | 4 | **26** | 20 | 3 | 54 |
| Least Favorite | 1 | 18 | 1 | ***34*** | | | | | | | |
| 15. Suburban Strip Shopping Centers | | | | | | | | | | | |
| Most Favorite | *3* | 13 | **33** | 5 | WTP.travel | 1 | 10 | **21** | **21** | 1 | 54 |
| Least Favorite | ***42*** | 2 | 4 | 6 | | | | | | | |
| 16. Suburban Shopping Malls | | | | | | | | | | | |
| Most Favorite | *2* | 18 | **31** | 3 | WTP.travel | 3 | 12 | **25** | 14 | 0 | 54 |
| Least Favorite | ***48*** | 0 | 1 | 5 | | | | | | | |

## • PARKING LOTS

| | A | B | C | D | no response | | no response | <5min | 5-15 | 15-30 | >30 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17. Most Favorite | 2 | 3 | 20 | **27** | 2 | WTP.travel | 3 | 12 | 18 | 20 | 1 | 54 |
| Least Favorite | 25 | 18 | ***4*** | 4 | 3 | | | | | | | |

NOTE: Numbers above in boldface indicate the greenest images of the group.

NOTE: Numbers above in boldface italics indicate the least green images of the groups.

Note: Numbers above in boldface are the most frequent amounts of time.

18. Parking Lots Relationships with Types of Commercial Businesses

| | A | B | C | D | E | no response |
|---|---|---|---|---|---|---|
| Discount Stores | **30** | 18 | 3 | 3 | 5 | 9 |
| Upscale Mall | 7 | 11 | 11 | **32** | 4 | 13 |
| Grocery Store | 14 | **23** | 4 | 7 | 7 | 14 |
| Strip Mall | **33** | ***25*** | 3 | 8 | 5 | 8 |
| Office Park | 1 | 8 | ***36*** | ***35*** | **39** | 2 |
| Restaurant | 14 | 5 | 10 | **20** | 7 | ***18*** |
| Outlet Center | ***21*** | **24** | 6 | 5 | 11 | 12 |
| Hotel | 0 | 6 | **35** | ***28*** | ***29*** | 4 |

Images in order of greenest to least green: D, C, E, A, B

Note: Numbers above in boldface are the most frequently selected slide for the type of commercial business.

Note: Numbers above in boldface italics are the next most frequently selected slide for the type of commercial business.

## NYC BUSINESS IMPROVEMENT DISTRICT TREE / HORTICULTURAL QUESTIONNAIRE

***Please circle all responses that apply.*** ***Feel free to make additional comments.***

1. Do the members of your Business Improvement District (BID) feel that trees and other horticultural elements (flowers, window boxes, container plantings etc.) serve an important purpose in the BID area? Yes No

2. Does your BID have horticultural / landscape elements? Yes No
   If yes, please circle the elements that apply
   - Trees in pits
   - Tree pit guards
   - Tree pit plantings
   - Trees in containers
   - Flowers in containers
   - Flowers in hanging baskets
   - Flowers on poles
   - Flowers in window boxes
   - Other ______________________________

3. Is there a staff person whose primary responsibility is to design, develop or oversee the horticultural elements in your BID? Yes No
   If yes, what is the job title? ________________________________________

4. For planting and/or maintenance of horticultural / landscape elements, does your BID rely upon staff personnel? Yes No
   If yes, how many people ____________________________
   Are green elements the only responsibility of the above employee(s)? Yes No
   If no, what other job(s) do they do? ___________________________________

   Or, for planting and/or maintenance does your BID rely on:

   | | | |
   |---|---|---|
   | Outside Contractors | Yes | No |
   | City Agencies (DOT, PARKS) | Yes | No |
   | Volunteers | Yes | No |

   Other _____________________________________

5. Have any of your BID members requested trees from the BID? Yes No

6. Have any of your BID members requested other types of horticultural elements? Yes No
   If yes, what type? _____________________________________

7. Have any of your members described problems related to trees or other horticultural elements in your area? Yes No
   If yes, what were the types of problems? __________________________________
   __________________________________________________________________

8. Are there physical or mechanical circumstances that limit your selection of horticultural elements? Yes No
   If yes, please circle those that apply
   - Vaults
   - Narrow sidewalks
   - Underground utilities
   - Street lighting
   - Other _______________________

9. Are there horticultural / landscape elements in other areas of the city that you find attractive and would like to have in your BID? Yes No
   If yes, what elements? _____________________________________

10. Have you previously requested trees from your Community Board or the NYC Department of Parks and Recreation? Yes No
    If so, how many ______________________________

11. Have you purchased trees through the One Stop Tree Shop or other private business? Yes No
    If so, how many ______________________________
    Name of Vendor ______________________________

12. Are you aware of any Parks Department regulations involving trees? Yes No

13. What is the approximate amount of money spent on horticultural/landscape elements in your BID in 1998 (including outside contractors and/or staff personnel involved in planning, design and maintenance)?
    Less than $1000
    $1000-5,000
    $5,000-10000
    $10,000 - 20,000
    More than $20,000

14. Do you foresee an increase or decrease in the 1999 horticultural budget?
    Increase Decrease
    From $___________ to $____________
    Why? ______________________________________________________________
    ______________________________________________________________

15. How many in-ground trees are in your BID? _______________________

16. How many tree containers do you have in your BID? ____________________

17. Do you plan to plant additional in-ground trees in your BID? Yes No
    If yes, how many ______________________

18. Are you planning to increase other horticultural / landscaping elements? Yes No
    If yes, please specify __________________________________________

19. Are tree pit guards used in your BID area? Yes No
    If yes, were they purchased by the BID or by individual businesses?
    ____________________________________________________________

20. Is your BID planning to purchase tree pit guards? Yes No

21. Would your BID be interested in tree pit guards that also function as bike racks? Yes No

22. Do the merchants in your BID feel the horticultural elements are "good for business"? Yes No

Thank you for answering this questionnaire. All responses will be kept confidential. Any information used in the final report will be in non-specific summary form only.

Questionnaire completed by: ____________________________________________

Position: ____________________________________________

BID name: ____________________________________________

Address: ____________________________________________

____________________________________________

Phone: ____________________________________________

Would you like a copy of the final report? Yes No

Please mail this questionnaire to Trees New York in the enclosed envelope.

***NOTE: The format of this 4-page survey was altered to fit the format of this book.***

## TREE INVENTORY SHEET

**Study Site Name:**

**Study Site Location:**

**Inventory Team:**

**Date:** Page of

| | Tree ID No. | Species | Trunk Diameter | | Tree Height | | | Canopy Diameter feet | Health Class | Ground Cover under Canopy |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | DBH inches | DBH Class | Ht to Bole feet | Total Ht feet | Ht Class | | | |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | | | | | | | | | | |
| 29 | | | | | | | | | | |
| 20 | | | | | | | | | | |
| 21 | | | | | | | | | | |
| 22 | | | | | | | | | | |
| 23 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 25 | | | | | | | | | | |

**DBH Class**
1= < 10 inches
2= 10 - 20 inches
3= > 20 inches

**Ht. Class**
1= < 15 feet
2= 15 - 35 feet
3= > 35 feet

**Health Class**
1= Dead/Dying
2= Poor
3= Fair
4= Good
5= Excellent

**Ground Cover**
1= Shrub
2= Grass
3= Pavement
4= ExposedSoil
5= Mulch

## Master Tree Database for Tree Benefit Analysis within Case Studies

| Scientific Name | Common Name | CG ID Code | CG SP Type2 | CG Shade Class | CG Canopy Growth Factor | CG Radius (ft) | CG Growth Rate | Max Crown Area (sq ft) | Max Crown Area (acres) | CG Max DBH (inches) | CG Max Ht Class | Max Crown Radius (ft) | Dirr/ Hortus3 Max Ht (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acer campestre | Hedge Maple | ACC | 2631 | 1 | 1.7938188300 | 13 | S | 962 | 0.0221 | 24 | 2 | 17.5 | 25-35 |
| Acer palmatum | Japanese Maple | JM | 2721 | 1 | 1.7840862300 | 8 | S | 2,827 | 0.0649 | 20 | 2 | 30.0 | 25 |
| Acer platanoides | Norway Maple | NM | 3631 | 5 | 0.9395953300 | 18 | M | 1,257 | 0.0288 | 36 | 3 | 20.0 | 40-60 |
| Acer rubrum | Red Maple | RM | 3421 | 5 | 1.6397195900 | 13 | M | 2,827 | 0.0649 | 28 | 3 | 30.0 | 40-70 |
| Acer saccharum | Sugar Maple | GM | 3631 | 5 | 2.0257992400 | 18 | M | 1,963 | 0.0451 | 26 | 3 | 25.0 | 60-75 |
| Acoelorrhaphe wrightii | Paurotis Palm | PS | 2113 | 1 | 1.0816250600 | 5 | S | 102 | 0.0023 | 4 | 2 | 5.7 | 25 |
| Ailanthus altissima | Tree of Heaven | AIL | 3511 | 4 | 1.0895632100 | 18 | F | 1,257 | 0.0288 | 42 | 3 | 20.0 | 40-60 |
| Albizia julibrissin | Mimosa or Silktree | MIM | 2711 | 1 | 1.3719135500 | 13 | F | 1,257 | 0.0288 | 18 | 2 | 20.0 | 20-35 |
| Amelanchier canadensis | Shadblow Serviceberry | AML | 2611 | 3 | 3.9979681900 | 10 | M | 491 | 0.0113 | 23 | 2 | 12.5 | 15-25 |
| Betula papyrifera | Paper Birch | PB | 3411 | 4 | 1.2346518700 | 10 | M | 1,590 | 0.0365 | 18 | 3 | 22.5 | 50-70 |
| Catalpa speciosa | Northern Catalpa | CAT | 3431 | 5 | 0.7244521000 | 10 | M | 1,257 | 0.0288 | 36 | 3 | 20.0 | 40-60 |
| Cedrus atlantica glauca | Blue Atlas Cedar | BAC | 3324 | 5 | 0.9890437600 | 18 | S | 1,257 | 0.0288 | 18 | 3 | 20.0 | 40-60 |
| Celtis occidentalis | Hackberry | HBR | 3531 | 5 | 2.5803772600 | 20 | M | 2,827 | 0.0649 | 28 | 3 | 30.0 | 40-60 |
| Cercidiphyllum japonica | Katsura Tree | CCP | 3421 | 4 | 1.3656081500 | 13 | M | 5,027 | 0.1154 | 22 | 3 | 40.0 | 40-80 |
| Chamaecyparis obtusa | Hinoki Falsecypress | CMC | 3234 | 2 | 0.7194812500 | 5 | M | 314 | 0.0072 | 18 | 3 | 10.0 | 50 |
| Cornus florida | Flowering Dogwood | DGW | 2721 | 1 | 1.7938188300 | 13 | M | 1,257 | 0.0288 | 24 | 2 | 20.0 | 20-35 |
| Crataegus phaenopyrum | Washington Hawthorn | HAW | 2421 | 1 | 0.6933744000 | 8 | M | 962 | 0.0221 | 20 | 2 | 17.5 | 20-35 |
| Fagus grandifolia | American Beech | BCH | 3431 | 5 | 5.9574406300 | 20 | S | 3,848 | 0.0883 | 36 | 3 | 35.0 | 50-70 |
| Fraxinus pennsylvanica | Green Ash | GA | 3621 | 5 | 0.8221198400 | 23 | F | 707 | 0.0162 | 35 | 3 | 15.0 | 50-60 |
| Ginkgo biloba | Ginkgo | GKO | 3621 | 4 | 0.6217526900 | 25 | S | 1,963 | 0.0451 | 36 | 3 | 25.0 | 50-80 |
| Gleditsia triacanthos inermis | Thornless Honeylocust | HL | 3411 | 4 | 1.1738207900 | 18 | M | 3,848 | 0.0883 | 32 | 3 | 35.0 | 30-70 |
| Ilex opaca | American Holly | HLY | 3333 | 2 | 1.3253023600 | 8 | S | 1,257 | 0.0288 | 20 | 3 | 20.0 | 40-50 |
| Juniperus virginiana | Eastern Red Cedar | RC | 3234 | 2 | 0.7194812500 | 5 | M | 314 | 0.0072 | 18 | 3 | 10.0 | 40-50 |
| Liquidambar styraciflua | Sweetgum | SWG | 3421 | 5 | 1.0994125300 | 18 | F | 3,848 | 0.0883 | 24 | 3 | 35.0 | 60-75 |
| Magnolia grandiflora | Southern Magnolia | MAG | 3325 | 5 | 1.8195226000 | 15 | M | 1,963 | 0.0451 | 36 | 3 | 25.0 | 60-80 |
| Magnolia x soulangiana | Saucer Magnolia | MAS | 2631 | 3 | 1.0786243400 | 10 | M | 707 | 0.0162 | 24 | 2 | 15.0 | 20-30 |
| Malus spp. | Crabapple | CRB | 2721 | 1 | 0.8791404200 | 5 | M | 962 | 0.0221 | 48 | 2 | 17.5 | 15-35 |
| Morus alba | Mulberry | MLB | 3631 | 5 | 1.3627307800 | 15 | F | 1,257 | 0.0288 | 28 | 3 | 20.0 | 30-50 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Picea abies | Norway Spruce | NU | 3324 | 2 | 0.7892069300 | 13 | M | 707 | 0.0162 | 34 | 3 | 15.0 | 40-60 |
| Picea pungens | Colorado Spruce | BU | 3334 | 2 | 0.8641547800 | 5 | S | 491 | 0.0113 | 32 | 3 | 12.5 | 30-60 |
| Pinus nigra | Austrian Pine | TP | 3324 | 2 | 0.9064936700 | 13 | M | 1,257 | 0.0288 | 28 | 3 | 20.0 | 50-60 |
| Pinus resinosa | Red Pine | RP | 3424 | 2 | 0.9766882100 | 15 | M | 962 | 0.0221 | 24 | 3 | 17.5 | 50-60 |
| Pinus strobus | Eastern White Pine | WP | 3324 | 2 | 0.9064936700 | 13 | M | 1,257 | 0.0288 | 32 | 3 | 20.0 | 50-80 |
| Pinus sylvestris | Scotch Pine | CP | 3324 | 2 | 1.0328771900 | 13 | M | 1,257 | 0.0288 | 24 | 3 | 20.0 | 40-60 |
| Pinus thunbergianna | Japanese Black Pine | JBP | 3424 | 2 | 0.9766882100 | 15 | M | 1,257 | 0.0288 | 24 | 3 | 20.0 | 70 |
| Platanus x acerifolia | London Planetree | LPL | 3721 | 5 | 1.5047567900 | 25 | M | 5,027 | 0.1154 | 42 | 3 | 40.0 | 70-100 |
| Populus tremuloides | Quaking Aspen | QR | 3621 | 4 | 1.9976964200 | 10 | F | 707 | 0.0162 | 14 | 3 | 15.0 | 40-50 |
| Prunus cerasifera | Purpleleaf Plum | PLM | 2621 | 1 | 1.0871609500 | 8 | F | 491 | 0.0113 | 18 | 2 | 12.5 | 15-30 |
| Prunus serrulata | Kwanzan Cherry | KWC | 2521 | 2 | 1.1391021100 | 8 | M | 1,257 | 0.0288 | 24 | 2 | 20.0 | 30-40 |
| Pseudotsuga menziesii | Douglas Fir | DGF | 3324 | 2 | 0.8856636600 | 8 | M | 314 | 0.0072 | 32 | 3 | 10.0 | 40-80 |
| Pyrus calleryana | Callery Pear | BDP | 3421 | 5 | 3.0823049200 | 13 | M | 1,257 | 0.0288 | 34 | 3 | 20.0 | 30-50 |
| Quercus acutissima | Sawtooth Oak | TO | 3621 | 5 | 0.8792879300 | 18 | M | 1,590 | 0.0365 | 24 | 3 | 22.5 | 35-45 |
| Quercus alba | White Oak | WO | 3721 | 5 | 1.4125261200 | 30 | M | 5,027 | 0.1154 | 48 | 3 | 40.0 | 50-80 |
| Quercus palustris | Pin Oak | PO | 3321 | 5 | 1.3276073000 | 18 | F | 1,257 | 0.0288 | 40 | 3 | 20.0 | 60-70 |
| Quercus phellos | Willow Oak | LO | 3421 | 5 | 1.6095379800 | 20 | M | 1,257 | 0.0288 | 48 | 3 | 20.0 | 40-60 |
| Quercus prinus | Chestnut Oak | EO | 3621 | 5 | 0.9026364900 | 20 | M | 3,848 | 0.0883 | 46 | 3 | 35.0 | 60-70 |
| Quercus rubra | Red Oak | RO | 3421 | 5 | 1.5681212300 | 25 | M | 4,418 | 0.1014 | 63 | 3 | 37.5 | 60-75 |
| Robinia pseudoacacia | Black Locust | BL | 3411 | 5 | 0.9193902200 | 13 | M | 962 | 0.0221 | 28 | 3 | 17.5 | 30-50 |
| Salix alba tristis | Weeping Willow | WWL | 3621 | 5 | 0.7453612100 | 23 | F | 5,027 | 0.1154 | 40 | 3 | 40.0 | 75-100 |
| Sophora japonica | Japanese Pagoda Tree | PAG | 3621 | 4 | 0.9026364900 | 20 | M | 4,418 | 0.1014 | 24 | 3 | 37.5 | 50-75 |
| Sorbus alnifolia | Korean Mountainash | SOR | 3621 | 4 | 1.9976964200 | 10 | M | 707 | 0.0162 | 24 | 3 | 15.0 | 40-50 |
| Thuja orientalis | Arborvitae | ARB | 2234 | 2 | 1.2383227400 | 8 | S | 177 | 0.0041 | 12 | 2 | 7.5 | 18-25 |
| Tilia cordata | Little Leaf Linden | LIN | 3631 | 5 | 0.8684795100 | 18 | M | 1,590 | 0.0365 | 30 | 3 | 22.5 | 60-70 |
| Tsuga canadensis | Eastern Hemlock | HEM | 3324 | 2 | 0.7918694700 | 15 | M | 707 | 0.0162 | 26 | 3 | 15.0 | 40-70 |
| Zelkova serrata | Zelkova | ZEL | 3521 | 5 | 3.4588261500 | 25 | M | 5,027 | 0.1154 | 28 | 3 | 40.0 | 50-80 |

*Note: CG = CITYgreen*

**Shade Class coding (1 to 5):**
1=least amount of shade
5=highest amount of shade

**Max Ht Class coding:**
1=Short <15 ft
2=Medium 15-35 ft
3=Tall >35 ft

**Growth Rate Coding:**
Fast: dbh@ 0.5 in/yr ht@3.0 ft/yr
Med: dbh@ 0.25 in/yr ht@1.5 ft/yr
Slow: dbh@ 0.1in/yr ht@1.0 ft/yr

**4-Digit SP-Type2 coding:**

| Mature Height | Crown Form | Leaf Density | Leaf Persistence |
|---|---|---|---|
| 1000 Short <15 ft | 100 Small dense | 10 Light | 1 Broad-leafed Deciduous |
| 2000 Medium 15-35 ft | 200 Columnar | 20 Medium | 2 Needled Deciduous |
| 3000 Tall >35 ft | 300 Pyramidal | 30 Heavy | 3 Broad-leafed Evergreen |
| | 400 Oval | | 4 Needled Evergreen |
| | 500 Vase-shaped | | 5 Semi-evergreen |
| | 600 Round | | |
| | 700 Spreading | | |

## ENVIRONMENTAL BENEFITS

A tree provides many benefits to the urban dweller, both psychological and environmental. Psychologically, trees relax a person and mentally calm them down. Environmentally, trees moderate climate, conserve energy and water, improve air quality, control rainfall runoff and flooding, lower noise levels, harbor wildlife, enhance the attractiveness of cities, and reduce summertime temperatures[1]. Trees make one's physical environment more livable by reducing noise pollution, improving water quality, and reducing the heat island effect. Trees create a pleasant place to relax in a quiet environment, with clean air and moderate temperatures. Open spaces with trees are nicer to live and work in; they make spaces more physically comfortable. So, developers can create a space where trees are a part of the design, not just for aesthetic reasons but for the environmental benefits that trees provide.

The concrete, stone, and metal of our homes, streets, and cars create a heat island that is very uncomfortable to live and work in. It can, however, be relieved with the trees and vegetation in the landscape[2]. Community heat islands exist because of decreased wind, increased high-density surfaces, and heat generated from human associated activities. These problems require additional energy expenditures, for heating and cooling, to off set their effects[3]. However, trees can reduce the heat island effect of northeastern metropolitan cities and towns. They help block heat buildup by reducing the heat radiated from concrete, stone, and metal surfaces. Trees also easily absorb carbon dioxide, sulfur dioxide, nitrogen dioxide and ozone, which helps to reduce the heat island effect[4]. Trees lower temperatures by shading surfaces, dissipating heat through evaporation, and controlling the air movement responsible for the advective heat[5]. So by planting trees a nicer, cooler environment is created to live and work in.

As trees reduce summertime temperatures, they also help raise the air quality of a city[6]. Trees serve as physical barriers to air-carrying pollutants. They allow winds to mix, dilute, and settle out pollutants such as airborne dirt, sand, dust, pollen, smoke, odors, and fumes[7]. The rate at which trees remove these gaseous pollutants depends primarily on the amount of foliage, number and condition of the tree's stomata, and meteorological conditions[8]. Trees also, through the sequestration of carbon, help reduce the green house effect. Air quality is an important issue for people when choosing homes[9]: the better the air quality, the more valuable the property. Trees can be planted to improve a cities air quality, both for residents and workers.

Through the rustling of leaves, trees mask unwanted noises. Trees also modify humidity and absorb sound, resulting in lower transmission of noise[10]. Noise reduction along roadsides in urban areas is often limited but with buffer plantings highway views can be screened[11]. However, noise reduction can be increased along highways if broader and denser plantings are used[12]. With proper initial planning, traffic and other street sounds can be blocked out with plantings. With this planning a developer can make work places more intimate and private and more inviting to visitors.

In the case of water, trees help control stormwater, raise water quality, and help slow erosion. With so much of a city covered with roofs and concrete, it is difficult for rainfall to reach the soil and normal rains will become floods. This requires costly stormwater systems to keep water off the streets. Trees and other vegetation can control stormwater because leaves catch and slow the rainfall lengthening the time it takes the water to reach the ground. This allows more time for water to soak into the city's limited open soil, instead of flooding. By planting more trees, there is more soil area created where water run-off can go making stormwater more manageable[13]. Tree roots also provide protection that slows water flow and reduces soil erosion[14]. A study done by the U.S. forest service showed that water run-off in forested areas is 17% less than that in developed areas[15]. By adding trees, rainwater run-off can be reduced and less money can be spent on stormwater systems. Trees can also raise the level of water quality in urban areas. For example, trees remove excess nitrate in subsurface run-off. Excess nitrate can cause health problems for children and very young animals by reducing the blood's capacity to carry oxygen[16]. By raising the water quality people will choose these cities as places to settle down because air and water quality are main factors when choosing a home[17].

Beyond water quality and air quality, trees provide a number of economic benefits through energy savings. There are three basic ways to gain or lose heat in a residential area: air filtration, heat conduction, and solar radiation. These losses can be cut through the use of shade trees, windbreaks, and foundation plantings[18]. Trees can create a space where heating and cooling losses are at a minimum. Energy savings can even be obtained from vegetation that does not directly shade buildings because of the magnitude of indirect effects of air temperature, airflow, and radiation generally increase leaf surface area[19].

When taking into account how much energy will be saved, it must be considered that trees take 5-15 years to grow large enough for savings to be recorded[20]. Energy benefits may be partially offset by problems that vegetation can pose such as pollen production, hydrocarbon emissions, green waste disposal, water consumption, and displacement of native species by aggressive exotic species. Potential energy savings of a tree might be offset by the cost of water, pruning, removal, litter clean up, pollen, health related problems and liability if the wrong tree is planted in the wrong place[21]. One should pay particular attention to the initial design and planting process to get the maximum energy saving benefits.

[1] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[2] *Barringer, Daniel ed. "Benefits and Values". NAA Fact Sheet.*

[3] *Coder, Kim D. Identified Benefits of Community Trees and Forests. October 1996. University of Georgia Cooperative Extension Service Forest Resources Unity Publication FOR96-39. (web)*

[4] *Kollin, Cheryl. On Balance: Weighing the Benefits and Costs of Urban Trees. Cooperative Project U. S. Forest Service Northeastern Forest Experiment Station and University of California, Berkley, April 1991.*

[5] *Coder, Kim D. Identified Benefits of Community Trees and Forests. October 1996. University of Georgia Cooperative Extension Service Forest Resources Unity Publication FOR96-39. (web)*

[6] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[7] *Barringer, Daniel ed. "Benefits and Values". NAA Fact Sheet.*

[8] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[9] *www.money.com, best places to live in 1998 "how we decided."*

[10] *McFarland, Kevin. Community Forestry and Urban Growth: A Toolbox for Incorporating Urban Forestry Elements into Community Plans. Washington State Department of Natural Resources, December 1994.*

[11] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[12] *Barringer, Daniel ed. "Benefits and Values". NAA Fact Sheet.*

[13] *Dwyer, John F. the Role Economics Can Play as an Analytical Tool in Urban Forestry. Bradley, G.A., ed. Urban Forest Landscapes. Integrating Multidisciplinary Perspectives. Seattle, University of Washington Press, 1995. Pp. 88-99.*

[14] *Huag, Joe, Ronald Ritschard, Neil Sampson, and Haider Taha. Cooling Our Communities: A Guidebook On Tree Planting And Light-Colored Surfacing. EPA: Policy, Planning and Evaluation (PM-221). 1992.*

[15] *McFarland, Kevin. Community Forestry and Urban Growth: A Toolbox for Incorporating Urban Forestry Elements into Community Plans. Washington State Department of Natural Resources, December 1994.*

[16] *Barringer, Daniel ed. "Benefits and Values". NAA Fact Sheet.*

[17] *www.money.com, best places to live in 1998 "how we decided."*

[18] *Powell, Kim. "Conserving Energy with Plants." North Carolina Cooperative Extension Service, Leaflet #621. 1993.*

[19] *McPherson, E. Gregory. "Net Benefits of Healthy and Productive Urban Forests". Urban Forest Landscapes: Integrating Multidisciplinary Perspectives. Ed Gordon A Bradley. University of Washington Press: Seattle & London. 1995. pp 180.*

[20] *McPherson, E. Gregory, and Rowan A. Rowntree. Energy Conservation Potential of Urban Tree Planting. Journal of Arboriculture. Volume 19, number 6. November 1993. P. 321-331.*

[21] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

## PSYCHOLOGICAL Benefits

Emotional attachment to trees is not easily quantifiable because it is unique to each individual. However, the value of trees to urbanites is generally underestimated[1]. The value of individual trees often depends on size and location, the most valuable trees in close proximity to buildings, roads, recreation facilities or utilities[2]. Trees also provide a number of psychological benefits for an urban resident or worker that can be used as a component to appraise urban forests. Trees can positively influence people's feelings, attitudes, moods and behaviors. They help shorten hospital stays and reduce the level of medication taken by post-operative patients. Trees and vegetation can have a strong relaxing effect, and reduce the mental fatigue of the urban resident. Trees attract people to outdoor public spaces, which improves opportunities for social interaction. This makes one's environment feel safer and more familiar. People have a great attachment to trees for the benefits that they provide psychologically.

A medical study done by Roger S. Ulrich showed that post-operative gall bladder surgery patients who had tree-views recovered faster, spending 8.5% fewer days in the hospital. They also took fewer moderate and strong painkillers, and required fewer costly injections. The patients who viewed buildings throughout recovery did not improve as quickly or easily[3]. This study coupled with another Ulrich study showing that vegetative scenery made people feel more relaxed and eased the stress of urban life. Trees and vegetation made it easier for one to focus on what is before them. Trees take away from the pressures of urban life and in the work place, their benefits are great for one's level of productivity. Alpha waves, a measurement of brain activity, were much higher when people viewed trees as opposed to urban scenes. Feelings of fear were also reduced when one viewed vegetation and trees[4]. Trees can provide other medical benefits for example, by cleaning the air trees help with respiratory difficulties. Trees in the long run can reduce medical costs[5].

A view of trees from the window of a car makes a difference in the mood of a commuter. Urban forests ease negative moods of commuters[6]. The benefits of trees are at their greatest when a person is experiencing stress or anxiety. On the other hand exposure to urban scenes markedly increases feelings of sadness[7]. Yet, with trees around people relax mentally. Trees create a calmer work place with their restorative benefits. Workers have an increased feeling of well being when they are around trees. Trees provide make people feel a lot more comfortable and relax them mentally. People are attached to certain types of landscape, landscapes that are not too complex and have very little slashed or downed wood. The landscapes that are very ordered, with a central focus point, are the ones that are the most enjoyed by the general public[8].

Trees create a nice atmosphere in neighborhoods, influencing the way that neighbors interact with each other. A study of a housing project showed that people were drawn to areas with trees, and these areas were where the main social interaction took place. Spaces without trees, however, were rarely visited, and never visited by adults[9]. Aesthetically trees also have a psychological effect: after a hurricane in South Carolina, the residents of Charleston responded to a survey where 10% of respondents said they had taken for granted how much they valued their urban forest[10]. Natural settings create nicer atmospheres that produce safer neighborhoods and better neighborly bonds. Trees are very beneficial to the psyche: they help relieve stress and clear ones mind of the problems within an urban realm. Trees decrease one's feeling of being crowded, making the atmosphere more comfortable to be in[11]. It has been shown that people who live in buildings with trees get more visitors because the environment is more pleasant and open. Trees create safer and healthier environments for people to live and work in[12].


1 *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

2 *Dwyer, John F. The Significance of Trees and Their Management in Built Environments USDA Forest Service, North Central Forest Experiment Station.*

3 *Ulrich, Roger S. View Through a Window May Influence Recovery from Surgery. Science. Volume 224, April 27, 1984.*

4 *Ulrich, Roger S. Human Responses to Vegetation and Landscapes. Landscape and Urban Planning. Volume 13, 1986. Pp. 29-44*

5 *Barringer, Daniel ed. "Benefits and Values". NAA Fact Sheet.*

6 *Hull IV, R.B. Brief Encounters with Urban Forests Produce Moods that Matter. Journal of Arboriculture. Volume 18, number 6. November 1992.*

7 *Ulrich, Roger S. Nature Versus Urban Scenes, Some Psycho-physiological Effects. Environment and Behavior. Volume 13, Number 5. 1981.*

8 *Ulrich, Roger S. Human Responses to Vegetation and Landscapes. Landscape and Urban Planning. Volume 13, 1986. Pp. 29-44*

9 *Coley, Rebekah Levine. Where Does Community Grow? Environment and Behavior. Volume 29, Issue 4. July 1997. Pp. 468-494*

10 *Hull, R. Bruce IV. "How the public values urban forests." Journal of Arboriculture 18 (2), March 1992*

11 *Coley, Rebekah Levine. Where Does Community Grow? Environment and Behavior. Volume 29, Issue 4. July 1997. Pp. 468-494*

12 *Lewis, Roger K. Urban Trees: Serving the Eye, Environment, Pocketbook, and Psyche. American Forest. Summer 1997, Volume 103, number 2.*


## VOLUNTEERS

Volunteers are often the backbone to any community project. Volunteers are willing to invest in their community and improving one's neighborhood is the primary reason for volunteering[1]. Tree volunteers are an important part of keeping trees alive and healthy. Volunteers feel that tree care and tree planting are the most satisfying activities because they are both physical and hands on activities[2]. In a poll done, thirty percent of residents identified the urban forest as being the most important to them: people value trees and will volunteer to keep their urban forests[3].

When a city lacks funds for trees, volunteers provide the city needs. For example, the Savannah Tree Foundation has sought, since 1982, to "preserve, nurture, and plant trees to enhance the quality of life for present and future generations" through land easements educational programs, and GIS based studies. The Savannah Tree Foundation, a volunteer organization, helps keep the city looking nice for tourists, which creates with business development and brings money into Savannah. The president of the Savannah Tree Foundation board said that "people come to see our built environment but they also feel a sense of appreciation for the live oak canopied squares and the amenities afforded by these trees[4]." The money produced from tourism shows that trees must be maintained in order to keep a certain level of money coming into the community. Therefore potential volunteers realize that they will be investing in their community.

Most potential volunteers are self-motivated to invest time in their neighborhoods because they want to improve and better the places where they live. Potential volunteers want to acquire new knowledge by learning about trees. There is also a great willingness among volunteers to perform a wide range of tasks, even tasks that they may have never have tried before. A statistic of potential volunteers showed that only 19% said that they both had not performed any tree volunteer activity and would not[5].

Potential volunteers often frequent botanical gardens and arboretum[6] where they can be asked directly to participate in volunteer activities. Developers need to target local residents with opportunities for improving their neighborhoods if they need volunteers to help maintain their trees and landscape[7]. Potential volunteers need little convincing that their city needs more trees and that existing tree care and management is an urgent necessity.

[1] *Still, Douglas T. and Henry D. Gerhold. Paper on Motivations and Task Preferences of Urban Forestry Volunteers. 1997. Pp.116-129*

[2] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[3] *Hull IV, R.B. Brief Encounters with Urban Forests Produce Moods that Matter. Journal of Arboriculture. Volume 18, num - ber 6. November 1992.*

[4] *Guglielmino, Janine. "Banking on Citizen Action". American Forests Autumn 1997.*

[5] *Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. "Assessing the Benefits and Costs of the Urban Forest". Journal of Arboriculture 18 (5): September 1992.*

[6] *Still, Douglas T. and Henry D. Gerhold. Paper on Motivations and Task Preferences of Urban Forestry Volunteers. 1997. Pp.116-129*

[7] *Rose, Robert L. The Urban Conscience Turns to the Environment. American Forests July/August 1988. Pp.17-20.*

## WORK SITE PREFERENCEs

In the workplace, trees can be very beneficial. Natural scenes sustain a person's attention and interest while urban scenes do not promote such relaxing qualities. A study done where participants viewed slides of urban and natural scenes showed that natural scenes increased the level of brain electrical activity. The alpha waves, an indicator of brain activation associated with wakefulness, of the participants in this study were consistently higher when viewing nature scenes. The participants felt more wakefully relaxed when they viewed trees and vegetation as opposed to urban scenes. Therefore trees can increase an urban worker's productivity level by relaxing her and decreasing her stress level[1].

Workers are more productive in wooded developments than in areas with strictly urban scenes filled with concrete[2]. For example, proofreading abilities are improved in an environment where people can take breaks with trees: by looking out their window or eating lunch in a tree-filled office park[3]. The stress of the workday can be relieved by experience in a natural environment. Researchers have also discovered that a person's sense of well being and productivity measurably increases because of trees; while stress and anxiety, on the other hand, decrease[4]. Trees create an environment that is more comfortable to work in, and that raises the level of productivity.

Trees can also enhance environments where people want to shop and spend their time and money[5]. They shape the landscape, especially an urban environment, by framing and enhancing buildings and providing a distinctive character and identity to developments. Trees are one of the last representatives of nature in the city, providing a constant reminder of the natural world beyond the city[6]. An investment in trees enhances economic stability by attracting businesses and tourists. The value of office and industrial space becomes more valuable to sell or rent because trees and vegetation are present[7]. Residents who chose Money Magazine's top 100 cities to live in, placed clean air, and good water quality as prominent reasons for their choice[8]. By planting trees, and creating green spaces, businesses will attract more potential workers and buyers to an area increasing. Trees make a workplace more desirable, to both the employer and employee. They help new developments become cherished workplaces, and places where people love to shop and spend their time.

[1] *Ulrich, Roger S. Human Responses to Vegetation and Landscapes. Landscape and Urban Planning. Volume 13, 1986. Pp. 29-44*

[2] *USDA. Benefits of Urban Trees. Forestry Report R8-FR 17*

[3] *Kaplan, Stephen. The Urban Forest as a Source of Psychological Well-Being. Bradley, G.A., ed. Urban Forest Landscapes. Integrating Multidisciplinary perspectives. Seattle, University of Washington Press. P.100-108*

[4] *Lewis, Roger K. Urban Trees: Serving the Eye, Environment, Pocketbook, and Psyche. American Forest. Summer 1997, Volume 103, number 2.*

[5] *USDA. Benefits of Urban Trees. Forestry Report R8-FR 17*

[6] *Dwyer, John F. The Significance of Trees and Their Management in Built Environments. USDA Forest Service, North Central Forest Experiment Station.*

[7] *USDA. Benefits of Urban Trees. Forestry Report R8-FR 17*

[8] *www.money.com, Best Places to Live, 1998*

# b i b l i o g r a p h y

Applebaum, William, Guide to Store Location Research, Addison-Wesley Publishing Company, 1968

Babbie, Earl, Survey Research Methods, 2nd Edition, Wadsworth Publishing Company, 1990

Bookout, Lloyd W., Value by Design: Landscape, Site Planning, and Amenities, The Urban Land Institute (ULI), date unknown

Coder, Kim, "Identified Benefits of Community Trees and Forests," published online at www.forestry.uga.edu/docs/comm.html

Ebenreck, Sara, "The Values of Trees" in Shading Our Cities: A Resource Guide for Urban and Community Forests, G. Moll and S. Ebenreck eds., Island Press, 1989

Fowler, Floyd J. Jr., Improving Survey Questions: Design and Evaluation, SAGE Publications, 1995

Gregory, Robin et al., "How Precise Are Monetary Representations of Environmental Improvements?," Land Economics, 71(4), November 1995, 462-73

Grey, Gene W. and Frederick J. Deneke, Urban Forestry, Wiley & Sons, 1978

Hanemann, W. Michael, "Valuing the Environment through Contingent Valuation," Journal of Economic Perspectives, 8(4), Fall 1994, 19-43

Hanley, Nick D. and R.J. Ruffell, "The Contingent Valuation of Forest Characteristics: Two Experiments," Journal of Agricultural Economics, 44(2), May 1993, pages 218-29

Haynes, Kingsley E. and A. Stewart Fotheringham, Gravity and Spatial Interaction Models, SAGE Publications, 1985

Kealy, Mary Jo and Robert W. Turner, "A Test of the Equality of Closed-Ended and Open-Ended Contingent Valuations," American Journal of Agricultural Economics, 75(2), May 1993, pages 321-31

Knetsch, Jack L., "Environmental Valuation: Some Problems of Wrong Questions and Misleading Answers," Environmental Values, 3(4), Winter 1994, pages 351-68

Krueckeberg, Donald A. and Arthur L. Silvers, Urban Planning Analysis: Methods and Models, Wiley & Sons, 1974

McPherson, E. Gregory, James R. Simpson, and Klaus I. Scott, "Benefits from Shade Trees in Parking Lots," briefing paper from U.S. Forest Service (Berkeley, CAresearch station), September 15, 1997

Nadel, Ira Bruce and Cornelia Hahn Oberlander, Trees in the City, Pergamon Press, 1977

Nelessen, Anton, "Visual Preference Survey," article on his company's web site: www.anavision.com/vps.html

Roca, Ruben A., ed., Market Research for Shopping Centers, International Council of Shopping Centers, 1980.

Schwanke, Dean, ed., Remaking the Shopping Center, Urban Land Institute, 1994

Smith, V. Kerry, "Can Contingent Valuation Distinguish Economic Values for Different Public Goods?," Land Economics, 72(2), May 1996, pages 139-51

Smith, V. Kerry, Estimating Economic Values for Nature: Methods for Non-market Valuation, New Horizons in Environmental Economics series, Elgar, 1996

USDAForest Service General Technical Report entitled "The Urban Forest Effects (UFORE) Model: Quantifying Urban Forest Structure and Functions," date unknown

Websites, various environmental advocacy organizations (such as American Forests, National Arborists Association, International Society of Arboriculture, etc.) found as result of Yahoo! Search under "community forestry."